ENGINEERING NEWS

AND

AMERICAN RAILWAY JOURNAL

VOL. XXVI. No. 27.

TABLE OF CONTENTS.

Engineering News of the Week 1, 10

Technical Articles:

Irrigation and Irrigation Systems in San Bernardino County, Cal. 2
The New System of Fire-Proof Floor Construction (*illustrated*) 2
Mannesmann Tubes for High-Pressure Transmission 3
A Curious Type of Arch Construction 3
An English Bridge Failure (*illustrated*) 4
The New Inlet Tunnel and Tower of the St. Louis Water-Works (*with inset, illustrated*) 4
Electric Train Lighting in England 5
Pipe-Laying Under the Mersey River 5
Coal Production in Illinois, Ohio, Indiana and Mississippi 5
Ozocerite or Mineral Wax 5
A Blast Furnace Blowing Engine (*illustrated*) 6
Disposal of Household Refuse 8
Receipts and Expenditure of 100 Principal Cities in United States 8
The Early Water Supply of London (*illustrated*) 9
Fire Tests of Plaster boards 9
A Curious Specification 9
The Nye Steam-Vacuum Pump (*illustrated*) 10
An Advance in Mine Ventilation Necessary 16
Hoisting Engines and Dipper Dredge for Montreal Harbor Works (*illustrated*) 16
Steam Engine Efficiencies (*illustrated*) 17
Electric Lighting in the City of London 19

Personals, New Publications, Society Proceedings 11

Editorial Notes 12, 13
Free Advertising—Steam Engine Efficiencies—A Bridge Failure in England.

Editorials:

Electric Currents and Mine Ventilation 13
English and American Railways 13

Correspondence: 15, 16
Accident at a Railway Crossing—Notes on English Railways; the Southeastern Railway (*illustrated*).

Construction News 19–22
Railways, City Transit, Highways, Bridges, Tunnels and Canals, Water-Works, Artesian Wells, Irrigation, Sewerage and Municipal, Electrical, Contracting, Proposals Open, Manufacturing and Technical.

IMMIGRATION REPORTS, for the 5 and 11 months ending May 31, show as follows:

	1890.	1891.
Month ending May 31	82,994	85,941
5 months "	211,227	256,990
11 " "	491,609	487,179

Of the totals in the 11-month period Germany sent 102,994; Italy, 65,606; Sweden and Norway, 41,801; Russia (except Poland), 37,559; Poland, 23,082, and the English Islands, 107,773. Switzerland sent 6,389, as compared with 6,206 from France. Austria-Hungary, excepting Poland, is credited with a total of 63,726. New York is the chief port of entry, as 393,239 out of the 487,179 immigrants landed at that city.

THE O'BRIEN & CLARK AQUEDUCT SUIT is still on trial. Mr. ELIHU ROOT argued a motion, this week, to dismiss the complaint, on the ground that the final estimate had been accepted, and its payment frequently requested by the contractors. This is the suit to recover $732,312 for alleged extra work on section 6 of the New Croton Aqueduct.

THE STEEL HIGHWAY BRIDGE to be built across the Arkansas River at Little Rock, Ark., will cost $275,000 and will be 1,636 ft. long, including the iron trestle work. It will consist of 5 spans, two 300 ft. each, one 220 ft., one 140 ft., and a channel span 350 ft., supported upon steel cylinders filled with concrete. The roadway will be 22 ft. wide, and there will be a 5-ft. sidewalk on each side. The channel span will be 50 ft. above high water. The Missouri Valley Bridge & Iron Co., of Leavenworth, Kans., has the contract.

THE TRANSATLANTIC RECORD for eastbound passages has been lowered by the new steamer *Furst Bismarck*, of the Hamburg-American Packet Company's line between New York and Southampton. She made the run from New York to Southampton in 5d. 21h. 10 min., arriving at the latter port on June 25. The *City of Paris*' record for westbound voyages, made in August, 1889, was 5d. 19h. 18 min. Her best record for eastbound voyages made in December, 1889, was 5d. 22h. 50 min. The *City of Paris*, however, runs to Queenstown instead of to Southampton.

THE WORLD'S FAIR DIRECTORY has received over 1,000 applications for space. This is ahead of the corresponding demand at Philadelphia in 1876. Out of a total of 36,000 exhibitors in Philadelphia only 800 applications had been received 16 months prior to the opening.

THE "WHALE BACK" STEAM BARGE *Colby*, which lately ran the rapids of the St. Lawrence on its way to sea, is 256 ft. long, 36 ft. beam and 22 ft. deep. Below the water line it has the fine lines of an ocean steamer, but above this point the sides round in like the back of a whale, and the cargo to be carried can be hermetically sealed in. In the stern of the sea-going type is a 1,500 HP. compound engine, with cylinders 26 and 50 ins. and 42-in. stroke. A deck house, raised upon iron posts, surmounts the stern and braces up the smoke-stack. This boat, the *Colby*, was built at West Superior, and left Duluth on May 25 with 77,000 bushels of wheat within her hull and towing another whale back tow-barge with 67,000 bushels, bound for Kingston. Her registered size is 1,000 tons, and when fully loaded she carries 3,000 tons. The *Colby* passed through the Welland Canal with a close fit as to length, and after unloading her cargo she ran the rapids "as steadily as a log." The inventor of the barge, Capt. ALEXANDER MCDOUGALL, was on board.

COAL IN THE STATE OF WASHINGTON is stated in a bulletin, issued by the State Board of Trade, to exceed in volume all that is in the Atlantic States combined. The known workable coal strata cover an area of over 1,000,000 acres. An area of 16,000 acres is being worked, with an output, in 1889, of 1,750,000 tons, and 2,250,000 tons is expected in 1891. Sixty other veins, covering about 30,000 acres, are being exploited, and will add to the output of 1892. The coal ranges in character from a true cannel, showing 88% volatile hydrocarbons, to a semi-anthracite of 91% fixed combustible carbon. The lignite measures cover 800,000 acres, with an output of about 1,000,000 tons in 1890. Good coal can be laid down at Puget Sound for $2.50 per ton, and sent to San Francisco for $5. Coal at the latter point costs $8.15 per ton.

THE WEATHER BUREAU is now transferred to the Agricultural Department, dating from July 1. This is in accordance with the act of Congress of Oct. 1, 1890. Prof. MARK W. HARRINGTON, professor of astronomy in the University of Michigan, at Ann Arbor, and editor of the *American Meteorological Journal*, succeeds Gen. GREELY as chief of the department.

THE STEAMSHIP *Keweenaw*, built at Bay City, Mich., is on her way to San Diego, San Francisco and Seattle, on the Pacific Coast. She has passed down the lakes and the St. Lawrence River, and was lately at Quebec. The *Keweenaw* is built of steel, and has a gross tonnage of 2,512 and a net tonnage of 2,004 tons. Her engines are 1,300 H. P. She was brought through the Welland Canal in two sections, with temporary bulkheads, and was united together again after she had passed the river and canals.

THE MOST SERIOUS RAILWAY ACCIDENT of the week was a freight wreck on the Black Hills branch of the Burlington & Missouri River R. R., June 25. A fast freight train of 23 cars ran into a washout. Three men were killed and 13 cars were wrecked.

BRIDGE ACCIDENTS are reported as follows: An iron bridge being built by the Empire Portland Cement Co. across the Erie Canal at Warren, N. Y., gave way June 28, throwing 9 men into the canal. One man was killed. A ballast train on the Atchison, Topeka & Santa Fé R. R. went through a bridge near Lyndon, Kan., last week. Nobody was injured.

A LOCOMOTIVE BOILER EXPLOSION occurred on the Central R. R. of New Jersey near Nesquehoning Junction, Pa., June 29. It is reported that the fire was found to be going out, and the fireman was about to make an investigation when the boiler exploded. Four men were killed. Apparently the crown sheet collapsed.

THE CHAMBERS LAKE DAM in Larimer Co., Col., gave way June 9, and the flood caused much damage to bridges and property along the Cache-la-Poudre River. The dam is said to have been 450 ft. long, 12 ft. wide at top, with slopes of 2 to 1, lowest at the middle, where it was only 22 ft. above low water. It was built of sand and logs, and had a spillway at one end, and two box culverts 6 ft. square. The foundation was defective. The reservoir drained an area of 15 sq. miles.

THE BRIDGE ACCIDENT AT BASLE, SWITZERLAND, is described in the *Cologne Gazette* of June 15, and in its general account this journal says:

"The unfortunate train was filled with passengers, because many people from Basle were going to visit the singing festival at Moenchenstein. The new bridge close to the station spans the river Birs, above rapidly flowing waters. The train consisted of 2 engines, 2 fast freight cars and 10 coaches. The bridge broke in two. The entire first part of the train was precipitated into the river, but 6 of the coaches remained on the track, held there by the tearing apart of the couplings which brought the Westinghouse automatic brake into action and resisted further progress. Up to the present 65 bodies have been found. Forty-one seriously injured passengers are lying in the Basle Hospital. The work of clearing away the debris is being performed slowly."

The passengers saved can thank our American invention—the Westinghouse air brake—alone for their safety; without it all on that train would inevitably have been killed or maimed. The moral should not be lost upon other railway corporations in Europe.

THIS SWISS BRIDGE DISASTER is also described as follows in the *Bischofszeller Zeitung*: Yesterday (June 14) a musical festival was held at the village of Moenchenstein, on the right bank of the Birs River, reached by railway in three-quarters of an hour from Basel. The combined attractions of pleasant weather and the festival induced a large number of people to leave Basel for Moenchenstein on that day, and an extra train was made up to accommodate the crowd. The regular train following was drawn by two locomotives, and contained at least 400 persons. When it reached the lattice truss bridge, about 49 ft. long, which spans the Birs, the structure sank, although the extra train had passed over it safely but a short time before. The assistant engine turned in falling and remained in the river bed with the wheels upward. The driver and fireman were both caught and held below their engine. The second locomotive remained upright after falling and the firebox was not submerged, so that the fire within it burned for some time. Two baggage and three passenger cars followed the engines and were totally wrecked. The Birs usually is quite small, but on this day was exceptionally high. A fourth passenger car partly fell, its front wheels resting on the wreckage and its rear wheels on the bank. The front of the fifth car was broken in and the roof of the sixth was demolished. The remaining cars remained on the track, but many of the passengers were injured by the shock.

A PLASTIC MODEL OF THE OROYA RAILWAY, over the Andes, is being prepared by Mr. J. L. THORNDYKE, the manager of that line, for exhibition at Chicago in 1893.

Irrigation and Irrigation Systems in San Bernardino County, California.

BY F. C. FINKLE, C. E.

One who has never visited San Bernardino County, and who has formed his opinions regarding irrigation development in this, the largest county of the state, simply by reading the reports heretofore published, has a very incomplete idea of what has been and is being done to make productive the vast areas of land heretofore barren only for want of moisture during the dry season. Only snatches have now and then been given to the world of what has here been done.

Land which formerly has been considered of no value except for sheep ranches has, by the intelligent expenditure of capital under the supervision and application of science, been converted into groves of oranges and other fruits which possess an actual value of from $1,000 to $3,000 per acre.

One can readily see that there is chance for profitable investment of money where land purchased for from $10 to $20 per acre can be made worth a hundred times that amount. Shrewd capitalists have not been slow to avail themselves of the opportunity thus offered them, not only to find a safe but also a well-paying investment for their capital. The result is that large tracts of land have been purchased by companies who have in various ways developed water or acquired water rights from natural streams and conveyed the water thus obtained by means of canals or pipes to the lands to be irrigated therewith. Other companies make a business of supplying water at an annual rental per acre supplied and thus sell their water to the land owners in this way.

But there is still another way, created by the laws of the state, by which owners of dry lands can make them productive. This is forming what are known as "Irrigation Districts." This is done under a statute known as the "Wright Act," a name taken from its author, which was passed by the State Legislature during the session of 1888. Although this law is of recent origin there are already many communities which have taken advantage of its provisions and organized irrigation districts. The law provides for the calling of elections within the boundaries proposed to be formed into an irrigation district for the purpose of deciding whether such district shall be formed. Before an election can be called a petition signed by a majority of the free-holders in the proposed territory must be submitted to the Board of Supervisors of the county within the borders of which such territory lies, asking that an election be called for the purpose of deciding the question of the formation of an irrigation district and the election of a board of directors and other officers for such district. It then becomes the duty of the Board of Supervisors to call such election, the result of which decides the formation of the district, and who shall be its officers. The officers elected are five directors, an assessor, a treasurer, a secretary and a tax collector. The Board of Directors have authority at any time after their election to call another election to determine whether the district shall issue bonds for defraying the expenses of obtaining water and constructing a system of canals, ditches or pipe lines for conveying and distributing the water over the district. Before calling such an election, however, the Board must engage the services of a competent hydraulic engineer, who shall make surveys, plans and specifications for the work and estimates of the total cost necessary for supplying the district with water. The bonds voted must be within the amount of the estimate of such engineer. If a majority of the electors of the district vote for bonds they are issued and sold by the Board of Directors in the same way as a city sells its bonds. The money obtained is then expended as outlined in the plans and specifications, after advertising and letting contracts, until the system is completed. The bonds bear interest, and are paid by taxes levied within the district. The irrigation system is owned and operated by the district through its officers and by means of money raised by taxation forever, while an election for choosing officers takes place every two years.

Having thus outlined the different ways in which the cost of constructing an irrigation system can be defrayed, a description will be given of what has already been done in this county, and what works are at present in course of construction.

The results of private enterprise will first be considered, and then those of irrigation districts.

The following are the principal irrigation systems in San Bernardino County which have been constructed by private capital organized into water companies, and the number of acres developed by each:

Water Systems.	Acres under ditch.
Jurupa Canal	15,000
Vivienda Pipe Lines	5,000
Riverside Canals	10,000
Gage Canals	15,000
South Riverside Pipe Lines	6,000
Ontario System	5,000
North Fork Canal	4,000
South Fork Ditch	4,000
Bear Valley Reservoir	18,000
Semi-Tropic System	15,000
Chino Pipe Line	2,500
Total	*99,500

In addition there are many other systems too small and numerous to be described in an article of this kind.

The above statement shows the area which each system will irrigate when all the land covered by it is brought under cultivation, and not what is actually being irrigated at present.

In many cases the companies are new and have just got their systems completed, and have not sold much of their land to actual settlers and cultivators as yet. The lands, however, are being offered at a low price, which still yields a large profit to the companies, and are thus being sold and brought under cultivation very rapidly, so that in a few years all the above figures will represent the actual acreage irrigated by each system, and not the ability to irrigate, as at present.

THE JURUPA CANAL.

The canal of the Jurupa Land & Water Co., constructed to irrigate 2,000 acres of the Rubidoux Rancho and 13,000 acres of the Jurupa Rancho, was completed only about a year ago, but there have already been sold something over 6,000 acres of land under this system, and nearly 1,000 acres have been planted to oranges.

The water is obtained from two natural streams and from developments in a cienaga containing numerous little springs and water sources. The portion of the water obtained from natural streams comes from Warm Creek and the Santa Ana River. The Warm Creek supply was obtained by the purchase of the major portion of the stock of the Agua Mansa Water Co., and turning that portion of the water of said company represented by the stock purchased into Jurupa Canal.

This was easily done, as the Agua Mansa Ditch has an elevation of 60 ft. more than the Jurupa Canal, and the two are distant only ¼ mile at one point. At this point a pipe line was built to convey the water from the Agua Mansa Ditch into the Jurupa Canal.

The supply from the Santa Ana River was obtained by purchasing outright the water of the Salazar and Velarde Ditch and turning it into the canal. Both the Agua Mansa and Salazar and Velarde ditches were old ditches, built by the Spaniards in the early history of California (about 1850), and were used by the Spaniards to irrigate their little ranches on the river bottom; but those lands have been devoted to other purposes, and no longer require water for irrigation.

The greater portion of the water supplying the Jurupa Canal, however, is that which is developed in the cienaga above referred to. For the information of those who do not know the term cienaga, it may be stated that it is a Spanish word meaning slough or swamp, and is used in California to denote a large tract of land covered with water coming from springs. The water was developed in the cienaga by a deep cut, in which was placed a drain consisting of a redwood flume with tight top and sides and open bottom to admit the water. It was found that by this means the entire cienaga could be drained, and many branches have been constructed, all adding to the amount of water until the required amount was developed. At the point where the drain leaves the cienaga the construction of the canal was begun, and continued until the most distant point on the land to be irrigated was reached, a distance from the source of about 18 miles.

The notable features of the Jurupa Canal are a trestle flume across the Santa Ana River; two tunnels, one through earth 4,000 ft. long and the other through a spur in the mountain of solid granite, 2,000 ft. long; a side-hill aqueduct of timber, which was at some length described by the writer in an illustrated article in ENGINEERING NEWS of May 17, 1890; and an inverted siphon, consisting of three 24-in. pipes, across the road at San Salvador. The siphon conveys the water beneath a highway from the flume crossing the Santa Ana River into the aqueduct above referred to.

There have been many miles of lateral ditches and pipe lines built from the Jurupa Canal to distribute the water from the main canal to different parts of the tract, and more will have to be constructed in the near future.

THE VIVIENDA PIPE LINES.

The pipe lines of the Vivienda Water Co. consist of two separate systems. One is an 18-in. pipe supplied from artesian wells in the San Bernardino artesian belt. This pipe line is of sheet iron, riveted, and dipped in asphalt. Not having to stand any heavy pressure it is of No. 16 iron, No. 14 Birmingham gage. The main line is 4 miles in length and empties into a small circular reservoir of Portland cement concrete situated on a hill adjoining the tract which the system is used to irrigate. From this reservoir the water is distributed in iron pipes varying in diameter from 8 to 4 ins. over the tract to the highest point on each 10-acre plat. The tract irrigated from this system is known as Colton Terrace and consists of 1,000 acres all planted to oranges. Some of the groves are already 14 years old and are yielding their owners from $100 to $500 per acre, net annual income.

The other system of the Vivienda Water Co. derives its water from a cienaga such as is above described in connection with the Jurupa Canal. The cienaga was called by the Spaniards *La Cienaga de los Coches* (meaning hog wallow) and was supposed to have no value except for providing a place where swine could enjoy the hot weather. But by draining this cienaga a supply of water was obtained sufficient to irrigate 4,000 acres of dry lands. The water is conveyed about one mile in a cement ditch and flume to a small reservoir.

From this distributing reservoir the water is conveyed in a 24-in. sheet-iron pipe, a distance of 7 miles, to the highest point of the land it supplies. The pipe line is of three different gages of steel, Nos. 14, 12 and 10, as the pressure at different points varies greatly. The heaviest pressure is 120 lbs. per sq. in., which is withstood by the No. 10 steel where the line crosses the Santa Ana River. On crossing the river, the company have not provided a trestle of their own, but use the railway bridge of the Southern California Motor Road Co., which is quite a saving.

At the end of the line the water is received in a small distributing reservoir, from which it is conveyed over the tract in cemented ditches and iron pipes.

The town of Colton also derives its water supply from the 24-in. pipe line of the Vivienda Water Co. The water is taken from the 24-in. line at a point elevated 1,150 ft. above sea level, and emptied into a small reservoir, from which it is conveyed to the town in an 8-in. sheet-iron pipe and distributed in smaller pipes over the town. The elevation of Colton is 900 ft. above sea level, and were it not for the small size of the mains the fire pressure would be quite good. Colton is a railroad town of 2,000 people.

(To be continued.)

*The total area of San Bernardino County is 16,000 sq. miles.

A New System of Fire-Proof Floor Construction.

In our issue of May 23 we published illustrations and a description of the MONIER method of arch construction, the cardinal principle of which is the use of concrete in combination with wires, which assist the material to resist tensile strain. A concrete arch or beam exposed to a transverse stress fails by tensile stress on its lower portion, since the compressive strength of the material is much greater than its tensile strength. By imbedding wires in those portions of the beam or arch which sustain a tensile strain, the strength of the beam is greatly increased.

The use of iron to resist tensile strain in combination with concrete in somewhat different form is proposed by Mr. F. H. KINDL, Pittsburg, Pa., en-

gineer for Carnegie, Phipps & Co., Ltd. He writes, under date of May 26:

We have at present in American practice three distinct methods of fire-proofing floors, the most primitive of which is the use of a brick arch and concrete filling as shown in Fig. 1. The system mostly used at present is a hard burned terra cotta arch with the core running in direction of the beam, as in Fig. 2, and the hard burned or porous terra-cotta with the core running at right angles to direction of the beam, shown in Fig. 3. All of these arches have their good features; the brick arch for its cost, and the arch shown in Fig. 2 for its large surface for cementing, and that shown in Fig. 3 for its greater strength, due to the most advantageous position of its material, viz., in the direction of the line of stress. However, all

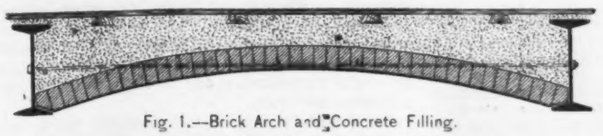


Fig. 1.—Brick Arch and Concrete Filling.

Fig. 2.—Terra Cotta Arch, Cores Parallel to Beam.

Fig. 3.—Terra Cotta Arch, Cores Perpendicular to Beam.

these arches when used on a span over 6 ft. must be carefully dealt with in all respects, and even then they have not always given satisfactory results as to their stability.

To insure ample strength, the writer suggests the use of a strap fastened by clamp or otherwise to the beams, the strap as well as the fastening to be of sufficient strength to take the strain coming upon it. This strain can very readily be figured, and thus any desired span can be constructed with safety.

The method of construction is very simple, as shown by Fig. 4, and is nothing more than straps put on each side of the fire-proof material and Portland cement poured over the top of the strap, which unites with the fire-proof material and makes a rigid support for it. It will also be seen that the fire-proof material can be cut in square blocks instead of in radial surfaces, which is necessary when it is to be used in the form of an arch. The use of tie rods, which must always be used in the methods illustrated in Figs. 1 to 3, is also dispensed with. Instead of the strap fastening to the beam, as shown, it can be fastened to the ends of the tile, if more desirable, by means of an angle iron running the full length of the top corner of the material, or by any other means which will give sufficient bearing value to take up the pressure coming from the strap.

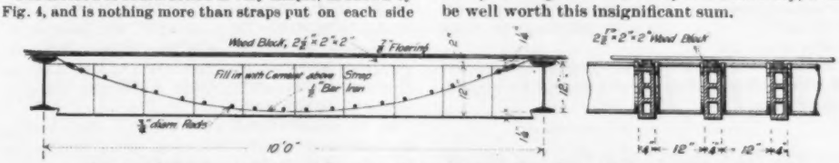


Fig. 4.—Suspension System of Fireproof Floor Construction. Broke at 300 Lbs. per Sq. Ft.

The practicability of this system was tested in a rude manner by building an experimental floor, as shown in Fig. 4, and loading it to the breaking point. This floor broke with a load of 300 lbs. per sq ft.; but if the fire-proof material had been closely laid together, and a sufficient number of straps had been placed in the same, it would no doubt have been good for 1,000 lbs. per sq. ft.

There remains no doubt that a large field is open to the use of these combination arches, in which the cement or fire-proof material is made to take the compression strain, while the tensile strain is taken up by suitable sections of steel or iron. You will find herewith inclosed two studies, with calculations which, if you think of sufficient interest, you may publish.

In the accompanying illustrations and table we reproduce one of the studies referred to by Mr. KINDL, which shows a total cost per sq. ft. of floor of only 40 cts. In our issue of April 19, 1890, estimates for several different styles of fireproof flooring were given, and the cost per square foot of the brick arch system was given as 66 cts., and of the hollow-brick system at 78 cts. It thus appears that the system proposed by Mr. KINDL is much cheaper than the methods commonly in use.

The second set of designs by Mr. KINDL, which we do not reproduce, differs little from the first, except that the suspension beams are spaced 16 ins. on centers instead of 12 ins., and wire lathing is used at the top and bottom of the air space instead of terra cotta lumber. The approximate cost per sq. ft. is $0.4172.

The only questions with regard to the excellence of this proposed system seem to be with regard to the strength of the strap. Mr. KINDL seems to make no allowance for concentrated loads, loss of strength in the strap at connections and reduction of strength by corrosion. In a fireproof building, safes are generally the heaviest concentrated load which the floor has to carry. The heaviest portable safe built by the Herring Safe Co. weighs, 11,400 lbs., and occupies a floor space of 5 × 4½ ft., making the load about 500 lbs. per sq. ft. Such heavy safes, however, are generally moved and put in place on timbers to distribute the load. But safes of this size weighing 6,900 lbs. are moved and placed without such extra precautions. The load per square foot in this case would be about 300 lbs.

The question of corrosion, especially in moist climates, is one which should be carefully looked into; doubtless the covering with concrete if carefully done would prevent rusting. On the whole, however, to make allowances for loss of strength through this cause, unequal distribution of strains, and heavy concentrated loads, it would seem wise to increase the size of strap over that designed by Mr. KINDL and make it $\frac{7}{16}$ or ½ in. thick. The additional cost of the heavier straps would hardly excel 1½ cts. per sq. ft. of floor, and the added stiffness, to say nothing of added safety and durability, would be well worth this insignificant sum.

DESIGN AND ESTIMATE FOR NEW FLOOR CONSTRUCTION.

Assumptions.

Span = S = 20 ft., clear.
Live load per sq. ft., 80 lbs.
Dead " " " 20 lbs.
C—C of beam, 10 ft.
Steel beams, 12 ins. 32 lbs., 22 ft.
Form of curve for strap = parabola.
Safe tensile strength, 13,463.5 lbs. per sq. in.

Strain in strap at T and T'

Nat. tang $v = \frac{S}{4h} = \frac{10}{4} = 2.5$

sec v = 2.3927

$T = \frac{1}{2} w \tan v = 500 \times 2.5 = 1,250$

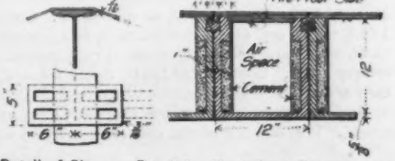
$T' = \frac{1}{2} w \sec v = 500 \times 2.6927 = 1,346.35$

Area of two straps necessary, 0.1 sq. in.

Smallest we roll = ⅛ × 1 and we will use this.

Bill of Material for 10 × 20 feet space.

One beam, 12 ins., 32 lbs., 22 ft	704 lbs.
20 straps, ⅛ × 1 in., 12 ft	100 lbs.
20 beam clamps	40 lbs.
Total, iron	844 lbs.
844 lbs., at 3.5c erected, = 25.13 at per sq. ft. =	$00.1477
60 cu. ft. T. C. L. at 24c. = 14.40 at per sq. ft. =	00.0720
Cement	00.0400
Flooring laid in place	00.0300
Plastered ceiling	00.0300
Setting tile arches in place	00.0400
Approximate total per sq. ft. in place	$00.3597



Detail of Clamp Detail for Hard-Burnt Fireproofing.

Mannesmann Tubes for High-Pressure Transmission.

At a recent meeting of the German Industrial Union, held in Berlin, and reported in *Industries*, Dr. W. SIEMENS gave some interesting information on the use of Mannesmann tubes for the transmission of naphtha at high pressures. Dr. SIEMENS owns the Kedeberg copper mines and foundries, in the Lesser Caucasus, the working of which was rendered difficult by the scarcity of coal and wood. Naphtha, which exists in bulk at Baku as raw petroleum, or the distilled form of it known as "masut," has been, therefore, utilized as a substitute for coal and wood in the working of copper. It is forced into large round furnaces, constructed after the pattern of Mr. F. SIEMENS, by steam at high pressure in the form of spray. Sufficient heat is thus produced to melt the ore after it has been mixed with the necessary fluxes, and the copper regulus is separated, which can then be further treated in similar furnaces. The transport of the masut was attended with great difficulty, as the works are situated on a high plateau, which descends with steep sides to the Kur steppes. The road from the railway station to the foot of the plateau passes over a steep mountain range more than 3,300 ft. high, so that mechanical transport was alone practicable. Cable railways and rack railways were projected, but the great difficulties of the ground and the unfavorable experience of Dr. SIEMENS with regard to the use of cable railways caused both these methods to be abandoned. The use of a tube was then suggested, by which the masut might be pumped up from the low-lying railway station. It was found that a pressure of about 1,500 lbs. per sq. in. would be necessary, and no tubes had been constructed hitherto which would bear such a working pressure except the Mannesmann seamless steel tubes. For some little time past one of these tubes has been in operation at Messrs. Siemens' works in the Caucasus. Its length at present is only 14½ miles, while the distance from the railway station to the works is about 28 miles. The tube at present raises the masut to the top of the plateau, but it is proposed to continue it as far as the works, although the transport on the plateau might be effected by other means. The pumps, which were made by Messrs. Humboldt, at Kalk, near Cologne, have been placed at the foot of the mountain, and raise the naphtha, at a pressure of 1,320 lbs. per sq. in., from a reservoir at the station to a reservoir which has been constructed on the top of the plateau. The internal diameter of the tube is 100 mm., and it is 4½ mm. in thickness. Completed tubes in long sections have been tested, with a pressure of 2,250 lbs. per sq. in., at the works of Messrs. Mannesmann, at Kommotau and Remscheid. The pump has raised hitherto 22 tons daily, but this amount might be increased considerably, since the pressure could be safely raised. There is no leakage in the pipe. Dr. SIEMENS stated that the erection of the installation would have been impossible except by using the Mannesmann tubes. He thinks that there would be no difficulty in constructing tubes which would bear a pressure of thousands of pounds per square inch, and that transmissions of high pressures for various purposes will henceforth come into more extensive use.

A Curious Type of Arch Construction.

In *L'Histoire de L'Architecture dans l'Antiquite*, by Messrs. PARROT and CHIPIEZ, is described and illustrated a curious form of arch construction, as applied by the Persians at Khorsabad. These arches have semi-circular, elliptical or ogival sections, and rest on vertical abutment walls of brick. Their peculiarity lies in the oblique arrangement of the brick rings.

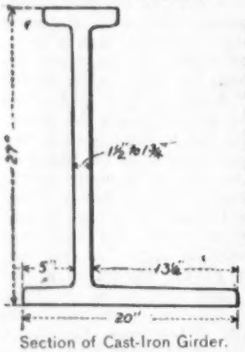
The ancient masons apparently did not use centers; so they started the first ring against a mass of brick masonry built with a face inclined at about 60° from a vertical plane. All succeeding rings were then supported against this first one, and all had this same inclination from the vertical. They did not use a keystone, but filled the opening left at the crown with brick clay, firmly rammed. The bricks used were comparatively thin and broad, and were shaped to conform to the lines of the arch. These drainage channels, so arched, were evidently well backed originally with earth

An English Bridge Failure.

In our issue of May 23 we briefly noted the failure of a bridge girder on the London, Brighton & South Coast Railway, in England, which by great good fortune, however, was attended with no loss of life. The report to the Board of Trade on this accident, by Major-Gen. C. S. HUTCHINSON, describes the bridge which failed (and it was a truly remarkable structure), as follows:

The Portland Road bridge, near Norwood Junction, carries seven lines of rails, of which four are running lines and three are sidings. Its span is 25 ft. on the square or 26¾ ft. on the skew. Each line of rails is supported by cross girders, each cross girder being formed of two rails bolted together, but separated by a shaped baulk placed between them, making their depth about 5 ins. and breadth about 8 ins. These cross-girders, the longest of which are 9¾ ft. long, are placed at central intervals of 3 ft., rest at each end on the bottom flanges of cast-iron girders, the centers of the webs of which are 10 ft. from center to center; the webs are not in the centers of the bottom flanges, which are 20 ins. wide and project 13½ ins. inwardly and 5 ins. outwardly. Each girder is 30 ft. long and has 10 sockets on the inside for receiving the ends of the cross girders, and there are also three stiffeners between the top and bottom flanges; the ends of the bottom flanges are splayed at the angle of the skew of the bridge. Each girder is 27 ins. deep, the thickness of the web being 1⅛ ins. to 1¼ ins., and of the bottom flange 1½ ins. at the outside and 1¾ ins. at the center. [A small sketch of the cross-section of this girder is given in our editorial columns.—ED.]

The girder which failed was the one at the west side of the up main line. It broke into three principal pieces, two of which, about 13¾ ft. and 11¾ ft. long respectively, fell into the road below, the other piece, about 4¼ ft. long, remaining suspended on the northern abutment. The primary fracture most probably occurred at the north end of the piece 13¾ ft. long, 1¼ ft. south of the center of the girder. This fracture was nearly vertical, at right angles to the bottom flange, and close to the inside of one of the cross girder sockets.



Section of Cast-Iron Girder.

The surface of fracture showed plainly the existence of an original flaw in the casting extending in the form of the letter L from a point in the web about 7 ins. above the bottom of the bottom flange to within about ⅛ in. of the bottom of this flange, and then turning along the flange toward its outer end for a length of about 5 ins.; the flaw would average about 1 in. in breadth and ⅛ in. in depth (though at one place the latter was as much as 3 ins.), the length being about 10 ins. The flaw was invisible either from above or below when the girder was in its site in the bridge, but the fracture revealed the fact that the flaw had extended to the surface of the web, where, however, it was covered by a thin sheet of wrought iron used in the operation of casting the girder and kept in position by a vertical piece of nail iron about ¼ in. square and about 7 ins. long (for supporting part of the mold between two adjacent gussets, running through the bottom flange, these pieces of sheet iron and nail iron thus forming an original part of the casting, the sheet iron covering the flaw and preventing it being visible).

The girders had been received from the Horseley Iron Company on Feb. 7, 1860, and, with the exception of a pair in another part of the bridge which were broken on Dec. 10, 1876, by an engine running off the rails of a siding onto the flooring of a part of the bridge on which at the time there were no rails laid, and which girders were replaced by others of similar construction, no change has been made in any of these girders since they were first put up in 1860.

	Tons.
The calculated breaking weight of the girder, according to the usual rule, would be, supposing the metal sound, about	71
But the existence of the flaw would reduce this by at least one-fourth, or leave the breaking weight not exceeding about	53

The engine which drew the express train would give a moving load equivalent to about 12.33 tons at the center of each girder, and the permanent load being equivalent to about three tons at the same point, the girder, according to Board of Trade rules (first issued in 1859), should have a breaking weight of

	Tons.
6 × 12.33	= 73.98
3 × 3	= 9.00
	82.98

The deficiency of strength being thus nearly 12 tons, supposing there had been no fl in the girder.

The above engine is not one of those in use on the Brighton company, which produces the greatest load on small bridges, there being another type in which the central load would amount to 12.45 tons on each girder of a bridge of 26¾ ft. span.

Heavier engines are run over the bridge, however, by the London & Northwestern Ry., some of them bringing a load of 14.3 tons on the girder. These girders were examined by the company's inspector in November last, when no flaw was perceptible. The bridge was covered underneath with corrugated iron plates, and no inspection of the bottom flanges of the girders from below had taken place since the bridge had been refloored about ten years ago.

Major HUTCHINSON censures the railway company as follows:

The attention of the Brighton company was drawn by the Board of Trade to this deficiency of strength after the occurrence of the accident on this bridge in December, 1876, when two identical girders at a different part of the same bridge were broken by an engine getting off the rails and they were then recommended to substitute stronger girders in their place, a recommendation to which unfortunately no attention was paid, or the present serious accident would have been prevented; the Brighton company is, therefore, in my opinion, deserving of much blame for having omitted to substitute stronger girders for the existing ones after attention had been thus specially directed to the weakness of the latter. . . .

Shortly before the accident an arrangement had been come to between the Corporation of Croydon and the Brighton Company to widen Portland Road bridge and increase the span from 26¾ ft. to 42 ft.; the work will now be immediately commenced, and meantime the existing girders have been supported in the middle by timber uprights under the bottom flanges.

The chief engineer of the company informs me that there are only 5 cast-iron girder under-bridges now existing on the main line between London and Brighton, and I trust that in view of this very serious accident no unnecessary time will be lost in replacing cast-iron girders (the use of which, except in an arched form, has been prohibited for under-bridges on new lines since August, 1883) by wrought-iron girders, both upon the main line as well as upon other parts of the system, and this more especially where the existing girders have not the margin of safety consistent with the use of heavy engines now employed upon the line.

The use of sheet iron and nail iron in connection with the casting of girders appears to be most objectionable, the former tending to prevent flaws being visible, and perhaps also tending to produce them, and the latter abstracting from the strength of the bottom flange of the girder.

We have commented at length upon this cast-iron girder and Major Hutchinson's report in our editorial columns.

The New Inlet Tunnel and Tower of the St. Louis Water-Works.

(WITH INSET.)

In our issue of April 18 we illustrated and described the settling basins connected with the extension of the St. Louis, Mo., Water-Works. As stated in that issue, the complete work will comprise an inlet tower about 1,500 ft. from the shore, a tunnel connecting the tower with the supply well of the pumping station, and a complete pumping plant, lifting the water into settling basins about 40 ft. above low water in the river. After depositing the bulk of its sediment, the water is drawn into a gravity conduit, and flows to the distributing reservoirs at Bissell's Point, 7 miles distant, the site of the old inlet works.

Our inset sheet this week illustrates the new inlet tower and tunnel, drawn from blue prints furnished us through the courtesy of Mr. S. BENT RUSSELL, Principal Assistant Engineer, who has prepared also the following description of the work:

The new inlet tower of the St. Louis Water-Works is located near the northern city limits, about 7 miles above the old intake, which is now in use. The tower is about 1,500 ft. from the west bank, on the west side of the low water channel.

The masonry of the substructure was completed May 2, 1891. The exterior is of granite. Courses 1 to 5, which are always submerged, and courses 14 to 20, which are above the stage of running ice, are quarry faced. Courses 6 to 12 are rough pointed, as they are exposed to the action of ice fields. Course 13 and the coping or cornice are 4-cut bush-hammered. The interior of the chambers is faced with bush-hammered limestone. The foundation, which was on a ledge of limestone, was leveled up with rich Portland cement concrete to receive the first course of stone.

The inset sheet also shows the general arrangement of the tower as it will be when completed by the addition of a gate-house and gates, with their hoisting gear. In ordinary operation, water will be admitted to the north chamber from the river. The lower gate in the south or downtake chamber is intended to be used in emergencies; and the upper gate in this chamber is to be used as an entrance, except in very high water.

Between the two chambers is a gate which will shut off the water from the tunnel in case of any accident to the working gates. All gates, except the last two mentioned, will be protected with heavy cast-iron screens. The gates will be opened and closed by hydraulic cylinders, operated either by a hand force-pump in the tower or by a pressure pipe from the shore.

The downtake shaft, which connects the tower with the tunnel, will be sunk and lined this fall if nothing prevents. The inlet tunnel has been driven from the uptake shaft to a point beneath the tower, and has been lined with brick for about half its length. The profile sufficiently describes this part of the work.

From the foot of the uptake shaft a short tunnel leads to a large shaft, which will contain steam pumps of a capacity of about 5,000,000 galls. per 24 hours, which will drain the tunnel when necessary. This pit pump-shaft is now being lined with brick.

At a higher level the inshore tunnel will connect with the uptake shaft, and will conduct the water to the screen chamber, where it must pass through wire screens before entering the wet well, from which the pumping engines draw. The tunnel and tower were designed to supply 100,000,000 galls. of water per day.

The elevations given on the drawings, and on the drawings of the settling basins given in our issue of April 18, are referred to a plane 100 ft. below the city datum. The city datum is about on a level with high water in the river.

The inlet tunnel and substructure of the tower, with downtake shaft, are being built under contract by Mr. R. P. MCCORMICK. This work is superintended by Division Engineer C. V. MERSEREAU, reporting to the writer, who has charge of the engineering work of the Water-Works Extension as Principal Assistant Engineer to Water Commissioner M. L. HOLMAN.

We are further indebted to Mr. R. P. MCCORMICK, the contractor, for the following notes on the construction of the tunnel and tower.

The contract for the work was concluded in January, 1890.

The tunnel starts from a 90-ft. shaft on the west bank of the river, and extends 1,555 ft. east to about the middle of the river, where a 40-ft. shaft connects it with the inlet tower. The minimum depth of water at this point is 12 ft. The total rise of the river is about 25 ft. The tunnel section is 10 ft. diameter, in limestone rock, and finishes to 7 ft. diameter inside of brickwork.

The driving of the tunnel commenced in April, 1890, and was completed in about 7 months; the largest drive in one month being 297 ft., with a loss of 4 days' time. All work has been done from the one shaft, as the river shaft is not yet sunk. The worst troubles encountered were from smoke and gas during bad weather, and from wet ground arising from leaks.

The cost of excavation has been $12 per cu. yd. It is to be remembered that the tunnel was of small size and was driven from a single heading where only three Ingersoll drills could work. This made the engine-house expenses heavy for the amount of material moved daily.

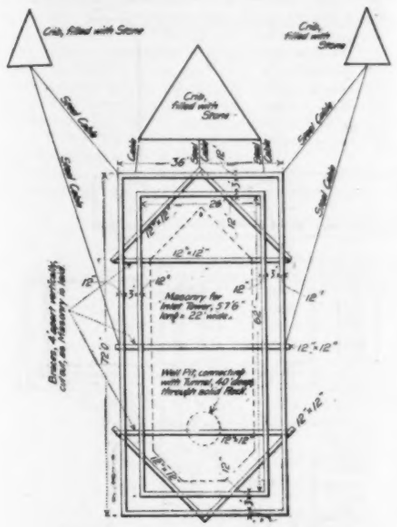
About 1,000 ft. of tunnel is now brick ed, and it wil take until Sept. 1, 1891, to complete the brickwork

A large shaft has been sunk 30 ft. north of the tunnel shaft, and to the same depth, 90 ft., in which will be placed pumps for emptying the tunnel of water when necessary. This shaft was sunk through 30 ft. of black soil and quicksand, and 60 ft. of solid rock. It is 22 ft. inside diameter and is lined with brick.

The inlet tower work was quite difficult on account of the necessity of locating a coffer-dam in the middle of the Mississippi River, where there is a cur

rent of 6 to 8 miles per hour. The site of the dam is near the head of a stone dike 20 ft. high. The bottom is rock and quite uneven. The northwest corner was about 3 ft. higher than the southwest corner; and the rock was full of grooves worn out by the swift current.

The accompanying sketch shows the construction of the coffer-dam. Before building it the rock on which it was to rest, which was covered at that time with 15 to 18 ft. of water, was blasted to something approaching a level surface. Three triangular cribs were then sunk just above the site for the dam and loaded with stone. Steel cables 1½ in. in diam-



Sketch Plan of Coffer-Dam and Cribs.

eter were attached to these cribs, as shown in the sketch, and held the dam in position while it was being built and sunk. The outside dimensions of the dam were 74 ft. length, 38 ft. width and 22 ft. height. It was built of 12×12 in. yellow pine timbers, drift bolted every 12 to 24 ins. with ⅞-in. round iron. The joint between each two courses was carefully calked. To support the sides of the dam against the pressure of water, three courses of 12×12-in. timbers were run across from side to side and served also to unite the interior frame of the dam to the exterior. These braces were put in every 4 ft. in height. They were cut out as fast as the masonry was laid. Besides these transverse supports, each end of the dam was braced by diagonal sets of 12×12 in. timbers, as shown in the sketch.

It will be seen that the large crib in front of the dam protected it from the force of the current. The space between the inner and outer walls of the dam was 3 ft. in width. After the dam had been sunk to the bottom of the river, this space was filled to a depth of 6 ft. with concrete in sacks. Puddle was put on top of this and clay in sacks around the outside. The dam was then pumped dry with one 10-in. pump. Some idea of the force of the current may be had from the fact that 8 ft. of mud and 60 sacks of concrete were found inside of the dam when the water was pumped out.

The total amount of timber in the coffer dam is over 125,000 ft. B. M., and over 12,000 lin. ft. of ⅞-in. round iron was used in making driftbolts. About 100 barge loads of clay and 1,000 sacks of concrete were used in making the dam and 10,000 sacks were used for depositing clay around the outside. Work on the dam was begun in August, 1890, and the heavy granite masonry inside, 50 ft. high, 24 ft. wide and 60 ft. long, was completed May 2, 1891, although running ice caused delay and trouble during the winter months. The total cost of the inlet tower will reach $100,000.

Electric Train Lighting in England.

At a recent meeting of the Institution of Civil Engineers, Mr. WM. LANGDON read a paper on the subject of train lighting which shows a considerable development of such service as compared with its use in this country. This will be seen by comparing the following abstract of the address with Mr. GEO. GIBBS' paper published in ENGINEERING NEWS of March 7, 1891.

In 1888 the directors of the Midland Ry. authorized the equipment of 2 trains to run between London, Manchester and Liverpool, in which the following conditions were to be fulfilled, viz.: (1) Each vehicle was to carry its own lighting power. (2) Each vehicle was to be capable of being coupled, uncoupled and turned about as needed, without the possibility of the connections being wrongly made. (3) The coupling must readily draw apart when coaches are slipped *en route*. (4) The act of drawing the coupling apart must make all the changes in the connections necessary to transfer the lamps from the dynamo circuit of the train to the accumulator circuit of the carriage itself. (5) Each compartment was to carry not less than 2 lamps. (6) The lighting throughout the train was to be capable of being turned on or off from any one of the guard's vans. There are now 5 trains leaving St. Pancras daily which are electrically lighted, and in which the dynamo is driven off the axle of the guard's van, each vehicle being provided with accumulators capable of supplying the necessary current without the assistance of the dynamo.

There is also a local train traveling between Manchester and Stockport lighted after the plan adopted by Mr. Houghton on the London, Brighton & South Coast Ry., but equipped with 2 sets of accumulators and 2 dynamos driven from the axle. In addition to the foregoing, there are 2 trains running between London and Bedford, the dynamos of which are driven by small high-speed engines placed on the locomotive.

In all cases where accumulators are employed, it is necessary (1) That the dynamo shall automatically come into circuit, when the requisite speed to enable the electromotive force of the machine to overcome the back electromotive force of the batteries has been attained. (2.) That the electromotive force shall remain practically constant whatever may be the speed of the train. (5) That the current shall always be in one direction, whichever way the vehicle is running. The first trains fitted on the Midland Ry. are furnished with machines giving a practically constant output of current, no matter how few or how many are the carriages attached. Messrs. Holmes & Co., of Newcastle, have succeeded in making a dynamo which affords a current proportional to the resistance of the circuit, and these machines are employed on all main line trains in which the dynamos are driven from the axle. Automatic apparatus effected the stipulated requirements.

The accumulators used were of the usual "E. P. S." type, 18 being carried in each car.

When trains are not broken up, the difficulty of providing an efficient electrical coupling is not great, but where the marshaling of carriages has to be smartly dealt with at terminal or intermediate stations, the coupling must be such as not only to provide a good electrical connection, but to admit of easy handling. The form adopted by the Midland Ry. effects these objects in a perfectly satisfactory manner. On a coupling being separated, the lights are automatically turned on. If the lamps are not required, the coupling, instead of being allowed to hang down, is placed upon a "dummy," the effect of which is to turn the current off. For slip coaches special provision is made.

By the insertion of a small resistance in each battery parallel, a fair distribution of the current throughout the different vehicles is attained, and in order to meet the increased pressure when the dynamo is in circuit, a sufficient additional resistance is automatically introduced. The lamps are of 8 c. p., and there are two in each compartment, safety fuses being provided in connection with each group as well as in connection with the dynamo itself. The circuits are arranged on the parallel system.

With regard to the second mode of generating the current, namely, by dynamos placed on the locomotive, it is believed that at present no other trains save the 3 already referred to are equipped in that way. Mention should, however, be made of experiments conducted on the Lancashire & Yorkshire Ry. in 1884, and also in the same year by Mr. W. H. MASSEY, on the Metropolitan District Ry.

The extra staff required consists, so far as the Midland Ry. is concerned, of one senior officer and two train attendants at St. Pancras, one train attendant at Nottingham, Manchester, Bradford, and the services of about 3 hours per day of a man at Derby. The total number of electrically lighted vehicles now in operation on the London, Brighton & South Coast, Great Northern and Midland systems is 365 coaches and 57 vans.

Pipe Laying Under the Mersey River.

In a general description of the Vyrnwy water supply for Liverpool, *The Engineer* shows a section of the flexible joint used in the steel pipe laid under the Mersey River, which practically explains itself. This water supply has long been delayed owing to the difficulties attending the construction of a pipe tunnel under the Mersey; which work was forced upon the corporation against the advice of the engineer, Mr. G. F. DEACON, by the Board of Trade, which declined to permit pipes to be sunk in the Mersey, as they have been in the Weaver River.

Temporary pipes have been sunk, however, and the work was finished successfully on May 31. This pipe is made of 50 sections of 12-in. tube, of a total length of 800 ft. This entire length was first sunk in a shore trench, and set on wooden ways or rails. Each joint rested on blocks of wood fitted to slide along these ways, and along each side, and passing through the blocks of wood, was a wire-rope. These two ropes were anchored at the in-shore end of the pipe, and extended across the river to a winch on the other side.

The trench for about 200 ft. from the water's edge was on a considerable gradient, and 8 boats were moored along the line to guide the pipe. As the bed of the river is very shifting, with new banks of silt forming at almost every tide, flexible joints had to be provided, as shown. While the river pipe is 12 ins. in diameter, the pipe leading from Norton Tower, 300 ft. above the river and 2 miles away, is 18 ins. in diameter, as is also the pipe leading from the Mersey to the Prescot reservoir. This head and diameter gives a discharge of 4,500,000 galls. daily through the 12 in. river pipe.

At neap tide the current velocity is 3 to 4 ft. per second and great precaution had to be taken against lateral movement. A heavy rope was stretched across the sterns of the moored boats, and guy ropes lead from this to timber bars lashed across the pipe to prevent it from overturning.

When all was ready the ways were soft-soaped, and with the combined power of horses and the steam winch on the far side of the river the pipe was started just before high tide. Two boats preceded the pipe and kept the head of the pipe up. It was successfully pulled across in 27½ minutes; the plug was taken from the end of the pipe and a temporary connection made with Norton Tower pipe, and within an hour from the start water was flowing under the river. The flexible joint worked so well that in about 24 hours the whole pipe was below the bottom of the channel. The sections have all been sounded and found tight. In mid-river a bank of sand and silt was cut away by allowing a water-jet to play from stops provided in the pipe. The whole operation was under the personal direction of Mr. DEACON.

Coal Production of Illinois, Ohio, Indiana and Michigan.

According to Census Bulletin No. 74, the coal production for the above states ranks as follows, when compared with the output and values of the census of 1880:

STATES.	1890.		1880.	
	Short tons.	Value.	Short tons.	Value.
Illinois	12,104,272	$11,755,203	6,115,377	$8,779,832
Ohio	9,976,787	9,355,406	6,008,595	7,719,667
Indiana	2,845,057	2,887,85	1,454,327	2,150,258
Michigan	67,431	115,011	100,800	224,500

The coal area in Illinois covers about 37,000 sq. miles; in Ohio, 10,000; in Indiana, 7,000, and in Michigan, 7,000 sq. miles. The coal from these states is bituminous, and adapted for steam and heating purposes. The cost of production and number employed in 1889 may be tabulated as follows:

	Employees.	Wages paid.	Total expenses.
Illinois	24,323	$8,694,347	$10,366,069
Ohio	19,504	6,892,604	8,232,183
Indiana	6,532	2,201,044	2,581,669
Michigan	....	93,504	113,714

Ozocerite, or Mineral Wax.

Ozocerite, prior to 1888, was only found in the province of Galicia, Austria, where it was first mined in 1862. In 1888 it was discovered in Utah, and since then has been commercially produced. The output; for Utah, in 1889, was 75,000 lbs. of the crude mineral, which, when refined, was reduced to 50,000 lbs., valued at $2,500. The production for 1890 will probably exceed 300,000 lbs.

Ozocerite is used for nearly all purposes for which ordinary beeswax is employed. It possesses all the properties of beeswax, except stickiness, but it can be given this property by mixing it with the wax Crude ozocerite is also used to a considerable extent as an insulator for electric wires. In 1889 1,078,725 lbs. were imported into the United States, valued at $86,682. These items are taken from Census Bulletin No. 75.

A Blast Furnace Blowing Engine.*

It is desired to present for comment and criticism a form of blast furnace blowing engine whose details are the result of an effort to design a standard form for such machinery.

The blowing cylinder is 84 ins. in diameter, the steam cylinder 42 ins. in diameter, and the stroke 60 ins. Some years ago blowing engines were ordinarily made with a stroke of 7 ft., and subsequently were made with a remarkably short stroke. It seems that the public demand for things brings about an averaging of mechanics' notions, and for good-sized engines the favorite stroke is now 60 ins.

The bed-plate is box form, 13 ft. long, 6 ft. 3 ins. wide, and 2 ft. 3 ins. deep, the metal entirely surrounding the rectangular section, excepting the opening for the removal of the cores. The two cross girders, forming the ends of the bed plate, and the side as far as the bosses for the steam cylinder, are 14 ins. wide. Besides the cross and box girders, there are two ribbed-plate cross girders which stiffen the entire frame at a point where the steam cylinder is bolted to the bed-plate. The bottom of the bed-plate is flat, to facilitate the bedding and to secure strength in the masonry. There are eight foundation bolts, each 2 ins. in the body, with 2¼-in. threads, passing through this bed-plate, and through the anchor plates which extend entirely across the foundation.

The bearing for the main shaft is made of cast-iron, babbitted, planed in and scraped upon the bed-plate. The seat of this bearing is well up, leaving the box frame under each bearing to receive weight of the fly-wheels and the thrust of the steam when they both come together at the bottom center, 24 ins. deep and 22 ins. wide, having 3½ ins. metal on top and 2 ins. on each side and bottom.

There are two housings or frames. They are hollow box castings of rectangular section. The section of each of the four legs is 22½ × 11 ins. at the bottom and 16 × 11 ins. at the top. They are bolted directly on top of the bed-plate, and on the top of them is bolted the lower head of the blowing cylinder, and they are in turn bolted to the steam cylinder near the top head, to give ample rigidity to the whole structure, while allowance is made for the expansion and contraction of the cylinder.

There are two fly-wheels, each 18 ft. in diameter, weighing 15 tons. They are made in two sections, planed at the joint and on one side of the center flange, after which they are carefully fitted and bolted with taper bolts to the crank-plate. The crank-plates are then forced upon the shaft and thoroughly keyed to it to remain there. The crank-pin holes are then bored out by using the main shaft to carry the bearings of the boring-bar, whereby accuracy in alinement and distance is secured. This is considered highly important in this type of engine, as in crossing the centers the slightest variation in the positions of the crank-pins will strain the whole engine. Rocking cross-heads do not relieve these strains, though they mitigate them, while with true work and occasional trammelling of the connecting rods they never exist.

The main shaft is of wrought iron, 15 ins. in diameter, with bearings 24 ins. long. The shaft is turned parallel, except a very slight reduction where the crank centers are forced on.

The lower head of the steam cylinder has four legs strongly ribbed to its whole surface. The bed plate has four pads or bases corresponding to those, and the lower cylinder head is placed upon these and accurately ad-

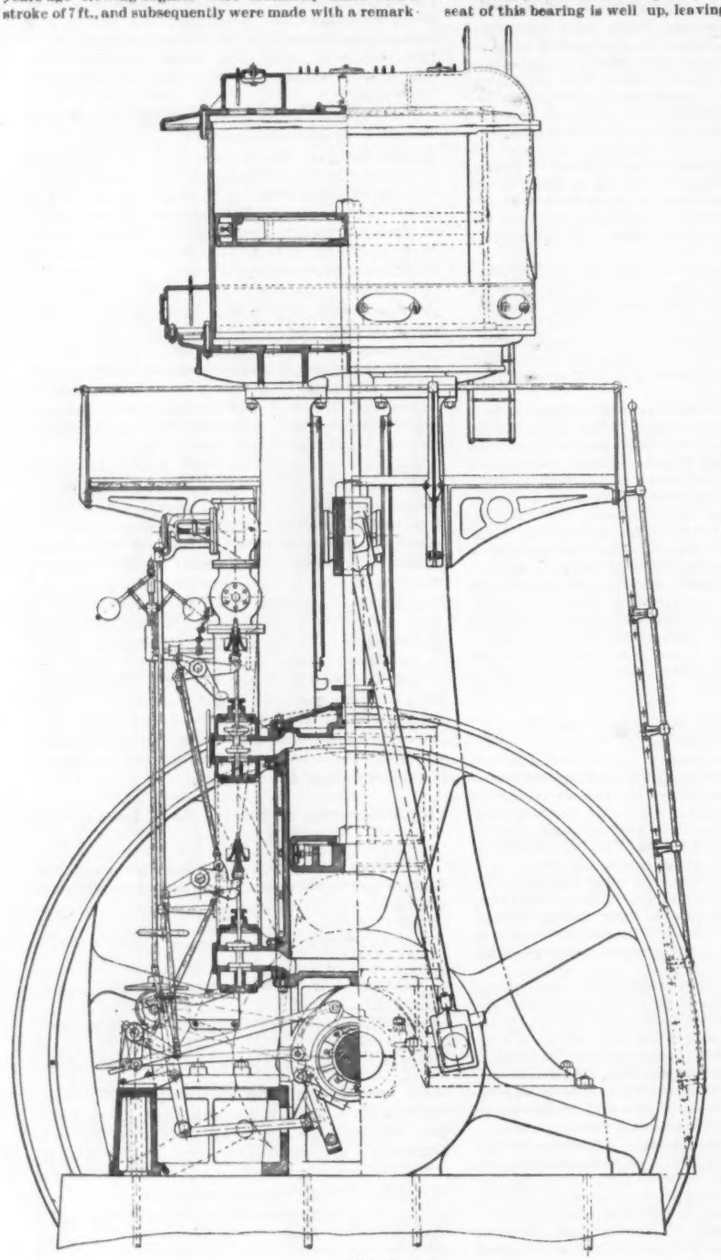


FIG. 1.

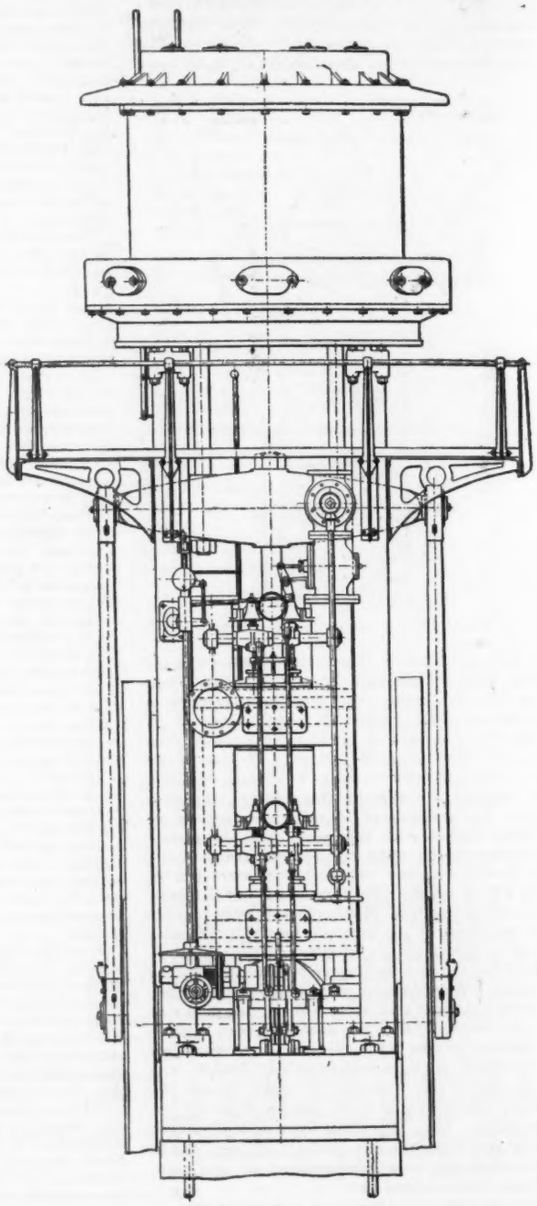


FIG. 2.

BLAST FURNACE BLOWING ENGINE BUILT BY GORDON, STROBEL & LAUREAU.

Steam cylinder—42 ins. diam., 60 ins. stroke; steam valve with instantaneous variable cut-off feed and invariable exhaust, controlled by variable speed; throttling governor, range 20 to 40 revolutions. *Blast cylinder*—84 ins. diam., 60 ins. stroke; all the air valves are seated by gravity and are of the Poppet type; inlet valves are made of vulcanized rubber; outlet valves are made of steel.

* A paper by Fred W. Gordon, Philadelphia, Pa., presented at the Providence meeting of the American Society of Mechanical Engineers.

justed in position, and is bolted to the bed-plate by four 3-in. steel bolts passing well into the bed-plate and keyed to it. Upon this lower head the cylinder is bolted in the usual way. The distance between the housings is just sufficient to admit the cylinder; and its width, added to the width of the two housings, is the width of the bed-plate. In other words, the housings are as close together as they can possibly be to permit the withdrawal of the steam cylinder. The length of the cross-head and shaft is reduced to a minimum, and the crank pins are brought as close as practicable to the fly-wheels. The crank pins are steel, 7 ins. in diameter, and being accurately bored, as above referred to, never heat with ordinary attention. (Figs. 1 and 2.)

The steam piston rod is secured to the steam piston by a nut on top of the piston head. This requires an enlargement of the rod at the lower end, the head to be passed over the rod and the nut following. The purpose of this is to get at the nut and screw it up properly, which is very difficult and is likely to be neglected when the nut is on the bottom of the piston. Should this large nut get loose on the bottom it may quickly run off, while if on the top it will work off very slowly and pound before any damage is done. The plan is certainly somewhat more expensive, but the difference in cost is justifiable.

The steam and exhaust valves are the ordinary double, balanced, poppet valves. The steam valves are made in one piece, the lower one being made small enough to drop through the seat of the upper one. They are 7½ ins. and 7 ins. in diameter, with an area of 82 sq. ins., or 6% of the area of the cylinder. This want of balance is to furnish a water relief through the steam pipe, as in the lifting of an ordinary slide valve. The exhaust valves have the lower valve the larger, which is introduced as a ring, the lower guide-stem being cast with the upper valve. The valve and seats are in all cases made of cast-iron, and seat at an angle of 60°. They are ground in with steam on the side pipes. The side pipes are each 12 ins. in the clear, the exhaust and steam being both alike. All the valves are actuated by a single eccentric, illustrated in the accompanying drawing (Fig. 1) and by the diagram (Fig. 3).

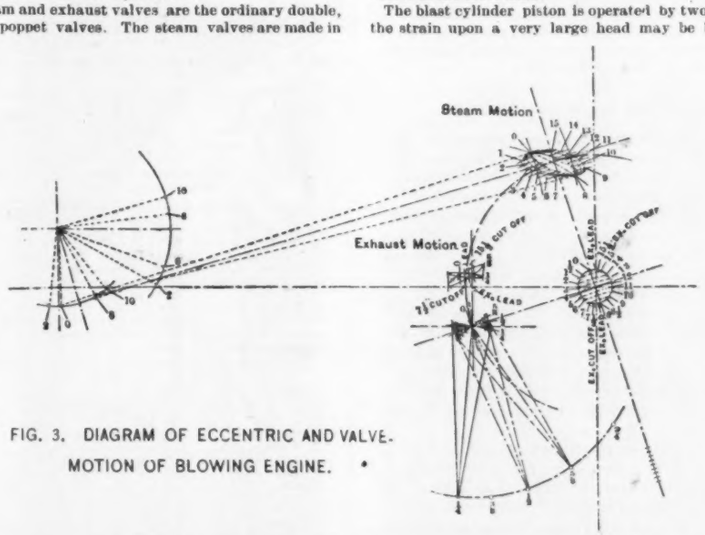


FIG. 3. DIAGRAM OF ECCENTRIC AND VALVE-MOTION OF BLOWING ENGINE.

The exhaust eccentric rod is pivoted to the eccentric, almost directly in line from the center of the shaft to the pin of the rock arm. This position secures practically invariable exhaust, there being no variation in the lead, and the lift and compression varying but slightly. The steam connection is pivoted to the eccentric strap, at right angles with its point of suspension, and in this position the most sensitive variations are obtained. By moving the hand-lever shown in the drawing the steam follow can be instantly changed from ⅞ of the stroke, or 11¼ ins. follow to ⅝ of the stroke or 37½ ins. follow, or between the expansion of 5 to 1 and 5 to 3. The action is entirely a rolling one upon pins, and is not liable to derangement of any kind, as there are no adjustments to make except when grinding the valves in. That required for wear of the main journal is effected by the screw supporting the small bracket, the only springs about the entire gear being upon the valves to cause them to close promptly. When the packing of the stems is screwed down too tightly, by setting this gear to secure the shortest cut-off while there is still an excess of speed to the engine over that desired, the governor, as shown, will control it with very little wire drawing and good economy will be secured. The drawing (Fig. 1) gives the impression that the clearance is large, yet it is but 3.4% figured on ⅞ ins. between the piston and cylinder heads at dead center.

The cross-head is a wrought iron forging 24 ins. deep in the center, the form being parabolic both above and below. The steam piston rod passes through the center, and is screwed up with a large nut on the top, the piston rod being 6 ins. in diameter. The blowing piston-rods pass through the bosses 20½ ins. deep and 9⅛ ins. in diameter. Each of these rods is 4¾ ins. in diameter, all the rods being steel. A cross-head constructed in this manner requires very accurate boring. The three holes must not only be actually parallel, but they must be at right angles with the centers of the end pins. This is attained by the use of a horizontal milling and boring machine of the Niles Tool Works' manufacture. The cross-head being set to the machine, the three holes are bored without again moving it. We do not even depend on the accuracy of the machine in this case, as the cross-head is set accurately to the spindle of the machine. The shoulders for the piston rods are brought exactly to the center of the cross-head.

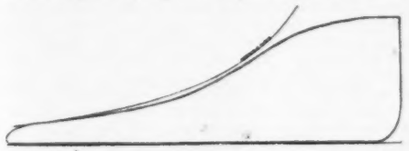


Fig. 4. Indicator Diagram from Steam Cylinder.

The blast cylinder piston is operated by two rods, that the strain upon a very large head may be better distributed than by the use of the central rod, and to effect better connections with the cross-head.

The connecting rods have solid ends, adjusted by keys, the brasses being very heavily backed with a wrought-iron pad. Each slipper is 10 ins. wide and 16 ins. long, or 320 sq. ins., to receive the strain. The pads have no provision for setting out, as the wear is insignificant, and when it is necessary we propose to introduce a liner next the cross-head. This makes a more rigid adjustment than any screw arrangement, and has to be done so seldom that the trouble of doing it is not worth consideration.

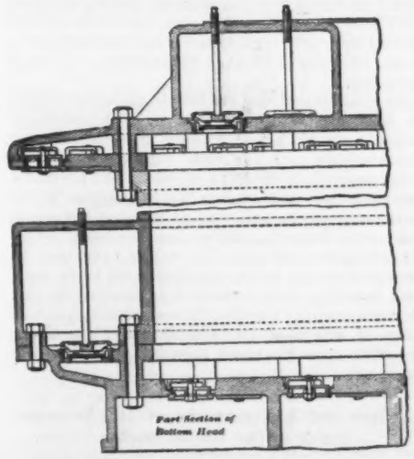


Fig. 5. Valves of Air Cylinder.

The blowing-piston packing-ring is brass, set out with springs with a long range of elasticity and light pressure. It is a single ring in segments accurately fitted together, and turned true on top and bottom and on the outside. The ring wears well and keeps tight, and requires no attention until a new one is needed. The follower bolts are screwed into brass nuts in the web of the spider, as difficulty has been experienced with nuts coming off.

The valves of the blowing cylinder (Fig. 5) are so disposed that they all fall to their seats by gravity, requiring no springs, and are readily taken out and replaced in every instance without entering the cylinder, and in a moment's time. The construction is readily understood from the drawing. The outlet valves are of steel with leather on the back (not on the face). The face of the valve is ground in the lathe where it seats, the seat being turned true to receive it. The leather is used only to avoid the slamming noise of the valve when opening. The valve gives a clear opening of 10.3 sq. ins., is ⅛ in. thick, and weighs but 6½ oz., which is .04 lb. per sq. in. The seat and guard are independent of the head, and together form the edge of the valve. Both are secured with a long bolt, adjusted from the outside, and are gotten at from the hand-hole openings placed conveniently around the outlet chambers. The surface of the cylinder receiving the cages is faced, as is the cage where it rests upon the cylinder. A cage can then be introduced and made secure at once without any jointings of gum or other packing being used.

The inlet valve is of similar construction, as shown in the large drawing, but the valve is made of pure vulcanized rubber, as good as the market affords; it is ⅜ in. thick and 4½ ins. in diameter. The inlet valve never comes in contact with a heated atmosphere; and this rubber valve (being absolutely tight) does not become heated and is very durable.

The outlet valves are made of metal, as they are subjected under pressure to a high temperature which soon crisps leather and softens rubber.

For quick-motioned engines, anything in the form of springs to close or ease its opening, or anything in the shape of hinges, where the wearing surfaces cannot be properly lubricated, is thought objectionable. The valve described avoids the use of hinges and wearing surfaces and springs. If the valves are heavy, or the use of springs is necessary to close them quickly, or if stiff hinges are to be overcome, there will exist a serious impediment to the flow of the air. The best which can be said of a valve is that it is only an interference to the direction of the flow, and this would be the case if it were as light as the air itself—lifting without resistance. To the inefficiency of the opening (caused by its form and the change of direction of the currents effected by the valve) must be added the weight of the valve or its resistance to opening to get the total difference between the pressure inside the cylinder and the atmosphere for the speed at which the air is entering.

Fig. 6. Indicator Diagram from Air Cylinder.

From this reasoning, it is apparent that the more freely the valve will open, the nearer it is to the requirements provided it will close with sufficient promptness to prevent a loss by the return stroke. We have found that there is no liability to loss in this, as the lightest valve prepares to seat itself as the engine approaches the center, and shuts itself instantly so far as the senses can appreciate it, the instant the center is reached.

These valves are made as large as it is thought to be advisable for great durability, and are made sufficiently numerous to give the requisite effective opening with a lift of but ⅞ in.

From the indicator diagram of the blast cylinder (Fig. 6) it will be seen that the inlet valves show so little resistance to the ingoing air that the lines on the card are not distinguishably separated. This was taken with a 10-lb. spring, the pressure by gage being 4½ lbs. and the speed 35 revolutions, the stroke of the engine being 4 ft. The outlet valves indicate a slight resistance, which cannot be measured, owing to the varying pressure in the outlet main.

Advocates of mechanically moved valves present three reasons for their use, all of which are theoretically very attractive. The first is the freedom from slamming and consequently less repairs; the second, efficiency of opening and consequently less waste of power, and the third less dead space.

From what we have said, and by the proof of the indicator card, we need not touch upon the two first, as we think the repairs of these valves are as light as could possibly be expected in any case, and the efficiency of the opening is all that could be wished. The clearance will bear very favorable comparison with any class of construction, being but 2$\frac{1}{16}$ %, including 9/16 in. clearance between the piston and the heads, which is rather more than is absolutely necessary; but, considering the character of the people into whose hands these engines sometimes go, we do not like to run them much closer. But leaving out this 9/16-in. clearance, the actual clearance due to the delivery or receiving chamber and valve cages is but 1⅛ %.

The engine is provided with a good substantial platform for ready access to every valve. The total weight of this

engine is 100 tons. It is designed to blow 15 lbs. pressure per sq. in. at 40 revolutions per minute, delivering 15,000 cu. ft. of blast per minute, piston measurement.

DISCUSSION.

Mr. WM. KENT said that while this engine is offered as a proposed standard form it really perpetuates the blowing engine which has been the favorite in American practice for the past twenty years, and the only improvements are in minor details. He believed that the whole breed of American blowing engines were a bad type. This engine probably weighs 100 tons, which is enormous for the power developed; it is probable that the weight is greater in the blowing engine in proportion to the power developed than in any other form of steam motor. The valve motion used on blowing engines is, he ventured to say, the worst since the days of JAMES WATT.

No one in times past has made much attempt to use steam with economy in blowing engines, for the waste gases from the furnaces are used in making steam. In modern practice, however, the rolling mill and the blast furnace are placed side by side, and there is a use for all the steam that can be made. In one part of the blowing engine, however, there has been a marked advance, namely, in the air valves. The air end of this engine is probably a very efficient machine. He had once made designs for a blowing engine to work with less waste of steam and be of lighter weight than the ordinary blowing engine, and he hoped yet to see engines of this type in use. The essential features of the design were simply the use of an engine of the marine type furnished with blowing cylinders.

Mr. J. F. HOLLOWAY defended the present type of blowing engine. He said the short-stroke blower which is now generally used has revolutionized iron making in America. One great difficulty in working blowing engines economically is that the leakage is not apparent and so the engine may work for a long time without its defects being discovered and remedied. With a pumping engine, leakage is apparent at once. Mr. KENT is not the first man who thought the manufacturers of blowing engines made a great mistake in building such heavy, wasteful engines, and that they ought to understand their business better. But none of the proposed revolutions in practice have as yet been successful. There is hardly any steam motor which is subjected to such trying conditions as the blowing engine. The air cylinder and the steam cylinder are on opposite ends of the same piston rod, and when the steam enters the lower cylinder at boiler pressure there is no resistance at all to the motion of the piston in the air cylinder. At the close of the stroke the conditions are reversed, the steam being expanded until the pressure on its piston is quite small, but the full resistance of the air piston continuing to the end of the stroke. In order to meet these conditions, fly-wheels have to be attached to the engine; and they must be heavy enough to absorb the work of the steam piston during the first part of the stroke, and prevent undue variations in the speed. This is one reason why so much iron has to be put into a blowing engine. For this reason alone he doubted whether it would ever be possible to have a very early cut-off in a blowing engine.

Mr. DANIEL ASHWORTH said he had given much attention to the design of blowing engines, and was confident that many engines now running had an excessive amount of compression in the steam cylinder. In reporting recently on an engine of this type, he warned the owners that the valve should be reset to do away with the excessive amount of compression at the end of the stroke. The matter was neglected and an accident resulted, the engine cross-head breaking under the combined resistance of the steam and air cylinders. Another direction in which blowing engines need improvement is in the substitution of positively moved air valves for those closed by air pressure and gravity. A new blowing engine fitted with positive moved valves has just been built for the Edgar Thomson works by the Southwark Foundry and Machine Co. [We have since been informed that while the valves on this engine are of new design, they are automatic and not of the positive closing type.—ED.]

Mr. F. MERIAM WHEELER said that improvements in blowing engines might be made by reducing clearance and increasing the piston speed, which in the engine under discussion is only 340 ft. per minute. He had made designs for a blowing engine to work at 100 revolutions per minute. Such an increase of speed might be expected to greatly improve the economy.

Mr. JNO. F. WILCOX, of J. P. Witherow & Co., said that three cylinder blowing engines had been built and were in service. Another member, alluding to the higher economy desired, told a story of a man who purchased a Corliss engine to run his saw mill, and as a result used so much less shavings and sawdust under the boilers that he had to keep a team and workmen employed to cart them away.

Mr. GORDON, in closing the discussion, said that there was some misapprehension concerning the need of economy in blowing engines. There is no steam to be thrown away with the most economical blowing engines; and, in fact, it is one of the greatest sources of anxiety to a furnace manager to get enough steam to keep the blowing engines up to speed. Extra fuel frequently has to be burned under the boilers for this purpose.

But one of the great obstacles in designing a blowing engine to contain the minimum amount of material and to work with economy is the great variation in blast pressure required. There are times in blast furnace work when the highest pressure which the blowing engines can possibly give, as high as 20 lbs. or more, is urgently needed, whereas ordinarily a pressure of not more than 5 or 6 lbs is required. Even with the present engines, higher pressures of blast than they can give are sometimes wanted; and in view of this state of affairs there is no demand among blast furnace men for a lighter engine. On the contrary, we cannot build them heavy enough to meet the demands. As to the steam valve gear, it is not as good as a Corliss, to be sure, but it must be built to go out in the woods and be subjected to rough handling. It must not be liable to breakage or derangement, for repairs are difficult and expensive and may necessitate the banking of the furnace. In setting the valves they are given a mere trifle of lead and about 2 ins. of compression, and both are invariable.

Positive moving air valves have been recommended, but if the automatic valves are made so light as to offer little resistance to the flow of the air and they close promptly, why complicate the machine by adding apparatus to move the valves mechanically? As a matter of fact, any one watching the valves shown in Fig. 5 will see that they close the instant the crank passes the center, and will appreciate the fact that no practical gain could be made by closing them more quickly.

Disposal of Household Refuse.

There are 750,000 tons of household refuse produced in London every year, says *Engineering*, and the authorities are at their wits' ends to know what to do with it. The "destructor," from which so much was expected, is proving unpopular in England, and it is now difficult to procure permission for its erection in any English town. The complaint is due mainly to bad management in handling the fires, or to carelessness. But the fact remains that they are too often a nuisance. At the present time London sends its refuse down the Thames on barges to the Essex and Kentish marshes, where population is scant and fresh air is abundant. In course of time a fairly productive soil results from the mixture of this refuse with the vegetable mould of the mashes.

A new process, however, is now on exhibition in London, that of The Refuse Disposal Co., Chelsea, and invented by Mr. JOSEPH RUSSELL and Mr. J. C. STANLEY. The salient feature of this process is that all dust, etc., is dealt with immediately upon its arrival at the works, and it is constantly in motion in thin layers, exposed to the air. The refuse is sorted by passing through cylindrical seives and screens, with meshes of 3 ins. to ½ in. square. Paper and rags are used for paper making; straw, for straw-board and burning; wood is burned; tin is saved for scrap; bones for manure; bottles and glass are resold or melted, and stones, vegetable and animal refuse, rubbish, coal, etc., are ground up and remixed with dust, and thus reduced to a harmless dry powder.

The cinders and coal are burned under the boilers, or they are saved and sold to brick-makers, or mixed with pitch and pressed into briquettes for steam raising, etc. The most valuable by-product is the paper made upon the premises. To prevent a nuisance from the smoke, the five boilers in the works are so aranged that an exhaust fan draws this smoke through scrubbers, and washes it before it is released in the air. The works have been in operation about 2 years, and about 5,000 loads have been treated. *Engineering* says that while this process solves the question from a sanitary point of view, it will want an examination of the books to decide upon the exact economic value of the process.

Receipts and Expenditures of 100 Principal Cities in the United States.

The matter contained in Census Bulletin No. 82 is peculiarly interesting, as showing the cost of government and the revenue of 100 representative cities of this country. When it is remembered that we have 443 cities with a population of over 8,000 each, the dimensions of the task of collecting this data can be appreciated. Of this total the 100 cities selected represent a total annual expenditure of about $35,000,000.

In comparing state and municipal expenses the statement is made that the expenses of the State of Massachusetts for the year ending Dec. 31, 1889, were $4,955,609, while the City of Boston in the same year expended $16,117,043. The expenses of the States of New York, Massachusetts, Pennsylvania, Ohio, Missouri and Illinois, the six largest states in population in the Union, amounted, in 1889, to an aggregate of $28,859,010; while the ordinary expenses of New York City alone amounted in the same time to $48,937,694. The salaries alone paid in certain cities were as follows: New York, $3.488,834; Brooklyn, $2,325,684; Philadelphia, $1,131,376.

The following table gives the hundred cities referred to in the order of their per capita of administrative expenditures, divided into four classes, cities having a population of 200,000 or upward constituting the first class; those having 100,000 but less than 200,000 the second class; those having 50,000 but less than 100,000 the third class, and those having less than 50,000 the fourth class:

FIRST CLASS—Population of 200,000 and upward—AVERAGE PER CAPITA, $15.98.

1 Cleveland, O.	$7.52	8 San Francisco, Cal	$13.96
2 Pittsburg, Pa	8.86	9 Philadelphia, Pa	13.97
3 New Orleans, La	10 51	10 Brooklyn, N. Y	17.34
4 Chicago, Ill	11.03	11 Cincinnati, O	17.54
5 St. Louis, Mo	11.12	12 Buffalo, N. Y	18.37
6 Detroit, Mich	12 31	13 Boston, Mass	23.74
7 Baltimore, Md	12.93	14 New York, N. Y	23 89

SECOND CLASS—Population of 100,000 to 200,000—AVERAGE PER CAPITA, $11.74.

1 Denver, Colo	$4.52	7 Jersey City, N. J	$10.57
2 Allegheny, Pa	5 24	8 Newark, N. J	10.97
3 Indianapolis, Ind	5.80	9 Rochester, N. Y	11.75
4 Kansas City, Mo	7 05	10 Providence, R. I	17.22
5 Louisville, Ky	8.25	11 Minneapolis, Minn.	17.53
6 Omaha, Neb	10.36	12 St. Paul, Minn	27.61

THIRD CLASS—Population of 50,000 to 100,000—AVERAGE PER CAPITA, $9.67.

1 Reading, Pa	$4 37	13 Paterson, N. J	$9.57
2 Dayton, O	5 30	14 Memphis, Tenn	9.87
3 Syracuse, N. Y	5.63	15 Charleston, S. C	10.07
4 Wilmington, Del	6.41	16 Lynn, Mass	10.26
5 Nashville, Tenn	6.8	17 Fall River, Mass	11.28
6 Des Moines, Ia	7.18	18 Toledo, O	11.44
7 Grand Rapids, Mich	7.48	19 Worcester, Mass	11.81
8 Troy, N. Y	7 48	20 Albany, N. Y	12.46
9 New Haven, Conn	8.13	21 Hartford, Conn	14.24
10 Lowell, Mass	8.58	22 Cambridge, Mass	15.76
11 Trenton, N. J	8.75	23 Columbus, O	16.70
12 Richmond, Va	8.92		

FOURTH CLASS—Population less than 50,000—AVERAGE PER CAPITA, $9.74.

1 Little Rock, Ark	$3.79	27 Taunton, Mass	$8.61
2 Oswego, N. Y	3.79	28 Topeka, Kan	9.06
3 Mobile, Ala	3 88	29 Holyoke, Mass	9.26
4 Jacksonville, Fla	3.92	30 Lynchburg, Va	9.44
5 Fort Wayne, Ind	4.32	31 Chelsea, Mass	9 50
6 Bay City, Mich	5.12	32 Bloomington, Ill	9.73
7 Meriden, Conn	5.50	33 Springfield, Mass	9.85
8 Oshkosh, Wis	5.50	34 San Antonio, Tex	10.14
9 Jackson, Mich	5.60	35 Lawrence, Mass	10.21
10 Racine, Wis	5.69	36 Salem, Mass	10.24
11 Wilmington, N. C	5.73	37 New Bedford, Mass.	10 41
12 Cedar Rapids, Iowa	5.85	38 Montgomery, Ala	10.52
13 Burlington, Vt	6.49	39 Galveston, Tex	11.10
14 Lewiston, Me	6.57	40 Bridgeport, Conn	11.44
15 Gloucester, Mass	6.60	41 Hoboken, N. J	11.94
16 Elmira, N. Y	7.04	42 Oakland, Cal	12.02
17 La Crosse, Wis	7.05	43 Seattle, Wash	12 03
18 Springfield, Ill	7.09	44 Savannah, Ga	13.99
19 Haverhill, Mass	7.14	45 Augusta, Ga	14.08
20 Dubuque, Iowa	7.21	46 Sacramento, Cal	14.63
21 Sandusky, O	7.54	47 Salt Lake City, Utah	14.69
22 Manchester, N. H	7.74	48 Yonkers, N. Y	16.25
23 Somerville, Mass	7.86	49 Bangor, Me	17 04
24 Wheeling, W. Va	8.06	50 Portland, Me	17.28
25 Leavenworth, Kan.	8.14	51 Duluth, Minn	26.31
26 Portland, Ore	8.48		

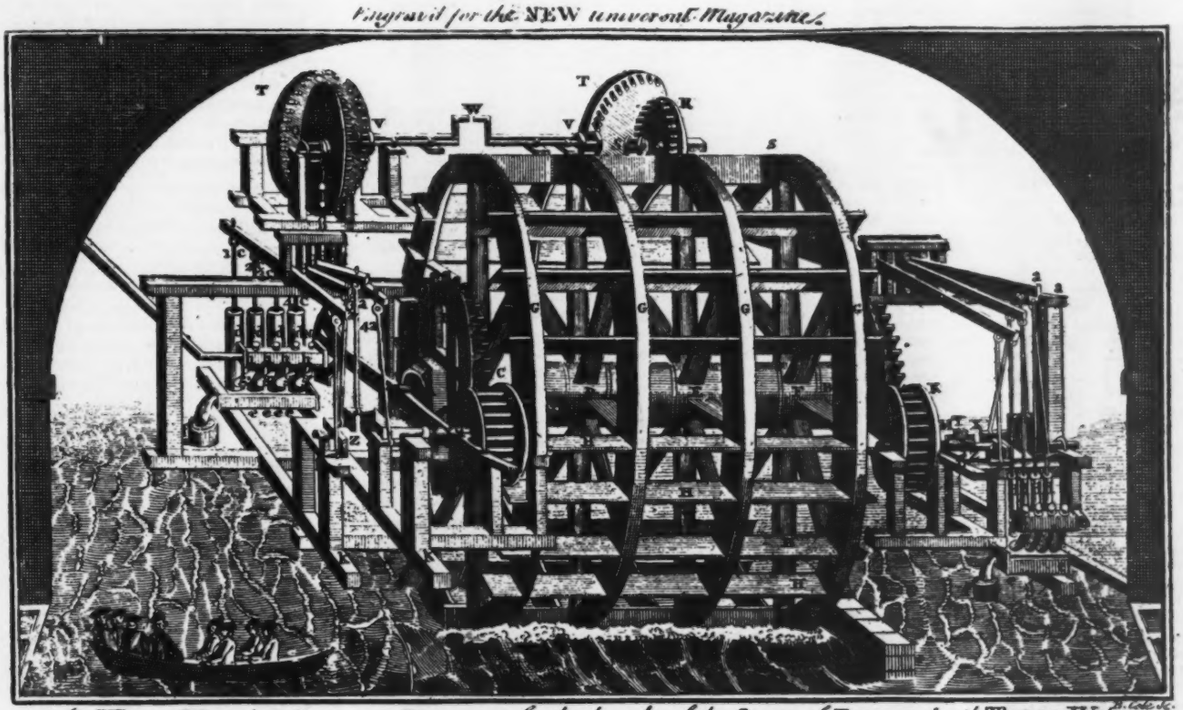
It will be seen that the approximate per capita administrative expenses for one year differ very much in the several cities, the lowest being that of Little Rock (Arkansas) and Oswego (New York), $3.79 each, the highest, Saint Paul (Minnesota), $27.61, the next being Duluth (Minnesota). It is also noticed that the average per capita expenditure of the first three classes grows less as the population decreases, a relation not true in case of individual cities. The high rate of per capita expenditures may be attributed in some cases to the extraordinary amounts expended on account of new sewers, streets, parks and other public improvements, which had not been separated in the accounts from amounts expended on account of those already in use, and, if the money was judiciously expended, its amount may denote a commendable public spirit instead of wasteful extravagance, but the figures given should suggest to the citizens of those places where such conditions exist a careful inquiry as to the cause of such extraordinary high per capita expenditures, an inquiry not within the scope of the Census Bureau.

The cities named are among the principal ones of all sections of the country as far as returns have been received, no minimum limit of population being recognized in making the selection. In the final volume, which will be ready this year, a like classification and grouping of the items of receipts and expenditures will be made of all municipalities in the United States having a population of 2,500 or upward from which returns can be obtained.

The Early Water Supply of London.

"In the time of the Conqueror," says Stow, "this city of London was watered (besides the famous river of Thames on the south part) with the River of Wells, as it was then called, on the west, with a water called Wallbrook running through the midst of the city, severing the heart thereof." Then they had Holy Well, Clement's Well and Clerk's Well, besides the "Horse Poole" in Smithfield, "sometime a great water," and another near the parish church of St. Giles without Cripple-gate. Langbourne Water was a "great stream" breaking out of the ground in Fenchurch St., and running down Lombard St. to the Thames. There were also private wells, "and after this manner was the city then served with sweet and fresh water." But in the process of time "the number of citizens being mightily increased, they were forced to seek sweet water abroad," and having turned their eyes to the remote district of Tyburn, one Gilbert Sanford, at the personal request of King Henry III., granted permission to the citizens to take water from thence in leaden pipes for the supply of "the great conduit in West Cheap builded in the year 1285." In 1438 the corporation under the same pressure went to Highbury; next year to the Abbot of Westminster's springs at Paddington, and even to Hackney and Islington. In the next century, about 1568, having exhausted all the supplies within their reach, they raised water by machinery from the Thames to a conduit on Dowgate Hill. We recommend to the consideration of the Lord Mayor and Corporation of London the way in which their predecessors attended to the supply of water to the city. "On Sept. 18, 1562, the Lord Mayor (Harper), aldermen and many worshipful persons, and divers of the masters and wardens of the 12 companies, rid to the conduit heads for to see them after the old custom, and afore dinner they hunted the hare and killed her, and thence to dinner at the head of the conduit. And after dinner they went to hunting the fox; there was a great cry for a mile, and at length the hounds killed him at the end of St. Giles'. Great hallowing at his death and blowing of horns, and thence the Lord Mayor, with all his company, rode through London to his place in Lombard street." In 1582 Peter Morrice, a Dutchman, raised water by a wheel from the Thames at London Bridge and conveyed it by small pipes to the houses—the greatest improvement in the distribution of water that had yet been made. In the beginning of the seventeenth century the City of London formed the really creditable project of bringing water to London from the Chadwell and Amwell springs, 21 miles off in Hertfordshire. Their conceptions had, however, exceeded their energy, and the scheme would have failed, at all events for a time, but for the accidental union in one man of three conditions which command success. Sir Hugh Myddelton, a citizen of London and a goldsmith (a trade in those days almost invariably connected with money dealing and financial operations), had been engaged in extensive mining transactions in Wales. In these occupations he had realized an immense fortune, and had acquired an unusual amount of practical engineering knowledge, to which qualifications he added the rarer one of invincible resolution. Wealth, skill and determination form in combination a power which accomplishes apparent impossibilities. He offered singly to bear the burden which was too heavy for the City of London, and successfully achieved what he had so boldly undertaken. On Sept. 29, 1613, the New River flowed into the town. At first it appeared that the Corporation had made a good bargain. For thirty years the dividends were not more than £5 per share; Sir Hugh, who had embarked his whole fortune in the scheme, sold his shares and died, comparatively speaking, a poor man. King Charles inherited from King James half the stock of the company, and sold it for £500 a year. But the practical monopoly of supplying a growing city with one of the primary necessities of life must sooner or later be profitable, and the dividends have gradually risen from £5 to £617 per share. Such are the results to an individual of undertaking a speculation offering a prospective rather than an immediate profit, and to a city of sacrificing the future to the present, and permitting the privilege of supplying its inhabitants with water to pass into the hands of a trading company.—*London Architect.*

Engraved for the NEW *universal Magazine.*



The WATER WORKS *at* LONDON-BRIDGE *for the Supply of the* CITY *of* LONDON *with* Thames Water.

Fire Tests of Plaster Boards.

In a recent number of the *Centralblatt der Bauverwaltung* was a description of some fire tests of plaster boards conducted last March at the Royal Testing Bureau for Structural Material at Charlottenburg. These boards, which are also manufactured in the United States, were described in ENGINEERING NEWS of April 12, 1890. According to the above paper, two models of houses, the dimensions of which are not given, were constructed with walls and ceilings of Mack's plaster boards. The plastering on the inner surface of the boards was only about 0.4 in. thick. In order to determine the temperature, different metals and alloys were placed in crucibles within these houses, the tests being made with (1) aluminum melting at 620° C., (2) an alloy of 800 parts of silver and 200 of copper melting at 830° C., (3) an alloy of 950 parts of silver and 50 of copper melting at 900° C., and (4) an alloy of 950 parts of silver and 50 of platinum melting at 1,100° C.

Within each house was piled about 225 lbs. of split fir, soaked with kerosene. Both fires were started simultaneously and maintained in the same condition as nearly as possible. At first no change in the houses could be detected, but after 30 minutes a few small cracks appeared in the joints, which had become slightly warm to the hand, although no change in the temperature of the plaster boards was perceptible. These cracks were probably due to the moisture in the joints, which were fresh, having been made just before the tests.

In one of the houses a portion of the plaster finish of the ceiling fell after the fire had been burning for 35 minutes, which was probably due to the smooth surface of the plaster boards and the very short time that the ceiling had to dry before being tested. At the end of 35 minutes more the fires were extinguished, and the plaster beams, which were nearly 4 ft. long between supports, were found to be uninjured, although large stones had been thrown against them and they had been subjected to the weight of a heavy man walking over their surface. Moreover, sheets of writing paper and pieces of lace curtain which were hung on the outside of the houses remained unchanged in any way. After the fire had been extinguished it was found that the temperature has been over 1,000° C since the first three alloys were melted, and the fourth only very slightly affected.

A Curious Specification

A correspondent sends us the following as a verbatim and literatim copy of a bid made for repairing work on a foundry:

ESTIMATE AND SPECIFICATION OF A REPARATION THAT J. J. D. ESQ. HAVE BEEN DESIRE TO DO.

To repair the old foundry of car wheel occupy by Mr. Geo. McD.

1°. To repair the north east backside of the building.
2°. " Take off all the backside of the building.
3°. " Lay down a soil behind, the same manner as firs one.
4°. " Posts will be all new one, and they will be fixed as they are at present.
5°. " Raise up again the backside of the roof, to be in good order for setting posts.
6°. " Set in order the roof around the Chimney b hind
7°. " Coil all in new the backside of the same manner that they were before.
8°. " Take off all the brick in the building and remove in lots at the same place.
9°. " Take away earth who will be an obstacle for working and to put out of the building.
10°. " We will past a board upright one at the other extremety of the pane.

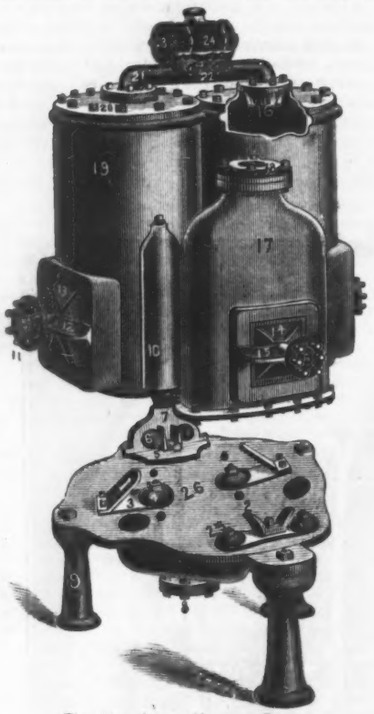
Thereof I obliged myself to make all these specification at the following price $125.

Signe, H. D.

The Nye Steam Vacuum Pump.

We illustrate herewith a style of steam vacuum pump which is being extensively used in the West, especially about Chicago, and which, as seen by the drawing, differs materially in its form from the older styles of steam vacuum pumps of which the Pulsometer is the best known type.

The pump consists of two cast-iron cylinders (each of which is alternately a suction and a discharge chamber) a condenser and discharging chamber (seen at the front of the cylinder in the drawing) and



The Nye Steam Vacuum Pump.

1, Suction Valve Stop; 2, Discharge Valve Stop; 3, Suction Valve, 4, Valve Washers; 5, Ball Valve Plate for Condenser; 6, Ball Valves for Condenser; 7, Condenser Cap; 8, Suction Flange; 9, Leg; 10, Condense Chamber; 11, Nut for Hand-Hole Plate; 12, Crab for Cylinder Hand-Hole Plate; 13, Cylinder Hand-Hole Plate; 14, Hand Hole Plate for Discharge Chamber; 15, Crab for Hand-Hole Plate for Discharge; 16, Steam Spray Basket; 17, Discharge Chamber; 18, Flange for Discharge Chamber; 19, Cylinder; 20, Cylinder Head; 21, Steam Chest; 22, Combination Air Cock and Check Valve; 23, Steam-Chest Head; 24, Steam Valve; 25, Discharge Valve; 26, Pump Base.

valves attached to the cast-iron base, covering the suction and discharge ports. The valves are of rubber and will wear about a year in ordinary work before requiring replacing. The steam valve seen on top of the cylinder is balanced and reverses automatically at each stroke. The Nye Steam Vacuum Pump Co., of Chicago, keeps these pumps in stock of capacities from 50 to 1,200 galls. per minute, at prices from $100 to $800.

LA TOURAINE, the latest steamer of the Compagnie Générale Transatlantique, reached New York on Saturday last after a passage from Havre of 7 days, 3 hours and 11 minutes. The best previous record was that of *La Bourgogne*, in 7 days 23 hours. The new steamship was built by the company at their works near St. Nazaire, France. She is 540 ft. long, 57 ft. beam and 38 ft. deep. The burden is 11,675 tons. On her official test she made 19½ to 20½ knots; and in going from St. Nazaire to Havre, she made the distance in 20½ hours, or at an average speed of a little over 21 knots. Her engines are 11,000 HP., and it is claimed that these can be worked to 13,000 HP. She has twin screws and triple-expansion engines, but no details have yet been made public as to her machinery.

A NEW HYDRAULIC BUFFER has been tested with considerable success at the Potsdam railway station in Berlin. It is reported to combine the advantages of the two leading English buffers of this kind, the Langley, used on the Great Eastern and Midland railways, and the Webb, used on the London & Northwestern Ry. A description of the latter will be found in ENGINEERING NEWS for Jan 24, 1891. The buffer heads are connected by a tie to counteract any diagonal blows, and the fluid used is a mixture of equal parts of glycerine and water.

AN ELECTRIC LAUNCH, made by Escher Wyss & Co., of Switzerland, is one of the most popular exhibits at the International Electric Exposition at Frankfurt. It is 49 ft. long, 10 ft. wide and of 3½ ft. draft. The propeller is 23 ft. in diameter, and makes about 350 revolutions per minute, with an expenditure of 10 HP. The electricity is taken from a battery of 56 secondary cells of the Oerlekon type, each of 450 ampere-hours capacity. The battery, when in series, has an E. M. F. of 110 volts. The motor of the series type has 2 poles, and an armature of the drum pattern, coupled directly to the propeller shaft. One charging of the battery is sufficient for a trip of 50 miles, and the boat is designed to make about 7½ miles an hour.

THE IMPORT OF IRON AND STEEL from England for May and the first five months of 1891 is as follows:

	May—		Five months—	
	1891. Tons.	1890. Tons.	1891 Tons.	1890. Tons.
Pig	3,178	11,931	15,519	44.495
Bar	204	319	1,439	1,864
Railroad	....	1,977	3,679	3,826
Wire	408	741	1,515	2,379
Hoops and sheets	630	1,547	1,958	4,997
Tinplates	55,569	25,619	190,686	108,734
Cast and wrought	236	398	992	1,483
Old iron	1,004	1,382	6,778	8,991
Unwrought steel	2,539	2,182	8,530	8,293
Totals	63,773	46,056	240,093	184,562
Exclusive of tinplates	8,204	20,437	40,410	76,328

This is an increase of 37% over 1890 for May, and of 34% for the five months. This is due, however, to the large amount of tinplate imported. Excluding tinplate the decrease is 40%.

A ROLLED STEEL PIPE plant for making pipe directly from the bar is in operation at the Alikanna Mills at Steubenville, O. The plant is owned and operated by the National Tube Works, of McKeesport, Pa.; but the exact process used is not made public.

THE CHINCOTEAGUE INLET IMPROVEMENT, commenced in 1886, is nearing completion. This canal is intended by the government as part of a plan to improve communication by small craft between Chincoteague Bay, Va., and the Delaware Bay near Lewes, Del. The new waterway just completed is 70 ft. wide and 4½ miles long, and passes through a low, marshy region lying between Little and Big Assawoman bays, which were once continuous. This now gives a passage 53 miles long. The next step is to dredge from Indian River Bay, through Rehoboth Bay and Lewes Creek to the Delaware above the breakwater, a distance of about 12 miles. This done, there would be a continuous waterway of 73 miles from Chincoteague to the Delaware Bay. The new inlet thus made will add 48,000 acres to the present oyster beds, besides giving a safer channel for small vessels.

THE COLUMBIA RIVER JETTY is a success, according to the last report to Major HANDBURY, U. S. Engineer in charge. The survey first completed shows a straight channel three-quarters of a mile wide across the bar, with nowhere less than 27 ft. in it. For 1½ miles in width, 25 ft. is the minimum depth. The distance across this bar to the 30-ft. mark on both sides is one half-mile. Major HANDBURY confidently expects 30 ft. of water in the channel clear across the bar by the end of this summer. The work was described at length in our issue of April 18.

THE PORT ROYAL, S. C., DRY DOCK is commenced, and is to be finished in 24 months from March, 1891. This is a Simpson timber dock to take ships 600 ft. long and drawing 30 ft. of water.

RAILWAYS IN SIAM are not yet under contract, and proposals for the construction of one line are now invited. This is the Nagara Rajasema line of the Royal Siamese State Railways, from Bangkok to Korak, about 165 miles. The contractor must, at the time of signing the contract, deposit 5% of the value of the whole contract, a requirement which will keep the list of bidders pretty small. Work is to be commenced in December and completed within 5 years. Details of the conditions of proposals will be found in our advertising columns. The proposals must be sent to the Minister of Public Works, Royal Railway Department, Bangkok, Siam, by Oct. 15. Further information can be obtained from the Siamese legations in Washington, London, etc.

THE FIRST RAIN GAGE, says Mr. G. J. SYMONS, was designed by Sir CHRISTOPHER WREN in 1663. This great architect also designed the first recording gage, but it was not constructed until 1670. The earliest known records of rainfall were made in Paris in 1668; Townley, Lancashire, in 1677; Zurich 1708, and Londonderry in 1711.

MR. CHARLES MACDONALD, M. Am. Soc. C. E., President of the Union Bridge Co., of New York, delivered the annual address to the graduates of the Rensselaer Polytechnic Institute, at Troy, N. Y. The address itself abounded with good advice to the young engineer, illustrated by the experience of the speaker and other engineers.

LEARY LUMBER CRIBS were at St. John, N. B., on June 26, on their way to New York. These new cribs are 16 in number, and are fastened together by a main chain running over the tops of the cribs, and the binding chains are shackled to it. Each crib is 55 ft. long, draws 12 ft. of water and holds from 600 to 700 sticks of timber, and they are connected to each other by 10 ft. of chain. One powerful tug will tow 8 of these cribs.

THE EAST AFRICA COMPANY, of Berlin, decided on June 25 to build a railway from Tanga to Korogwe, in Africa, to cost "62,500,000 marks." There is probably a cypher too much in the price telegraphed, as this would amount to over $16,000,000.

THE LOWER PART OF THE COLORADO DESERT, near Salton, Cal., has been suddenly flooded by water coming through the salt deposits in this region. This desert covers about 3,000 sq. miles and is 270 ft. below sea level at its lowest point. On June 27 streams of water were seen coming from the southern part of the desert, and in two days, says a telegram to the New York *Tribune*, a salt lake 14 ins. deep and 8 by 13 miles in area surrounded Salton. The only theory advanced is that it is caused by the pressure of water from the Colorado River, which is now in flood and borders the east edge of the desert. The Indians say the same thing happened about 50 years ago.

THE POPULATION OF THE PRINCIPAL ENGLISH CITIES for 1891, as compared with 1881, is as follows:

	1881.	1891.	Increase, per cent.
London	3,815,544	4,211,056	10.4
Liverpool	552,508	518,000	— 6.2
Manchester	462,303	505,300	9.3
Birmingham	400,774	429,200	7.1
Leeds	309,119	367 500	18.9
Sheffield	284,50	324,200	14.0
Bristol	206 874	221,700	7.2
Bradford	194,495	216,300	11.2
Nottingham	186,575	212,000	13.6
Salford	176,235	198,800	12 4
Newcastle	145,359	186,300	28.2
Hull	165,690	183.800	10.9
Portsmouth	127,989	159,200	24.4
Leicester	122,376	242,100	16.1
Oldham	111,343	131,500	18.1
Sunderland	116,542	130,000	12.5
Cardiff	82,762	128 9 0	55.7
Blackburn	104,014	120,100	15.4
Brighton	107,546	115,400	7.3
Bolton	105,414	115,000	9.1
Preston	96,537	107,600	11.4
Norwich	87,842	100,900	14.9
Birkenhead	84,006	99,200	18 1
Huddersfield	86 56 2	95,400	10.3
Derby	81 168	94,100	16.0
Plymouth	73,794	84,200	14.1
Halifax	73,630	82,900	12.5
Wolverhampton	75,766	82,600	9.0

There is only one city, Liverpool, which shows a increase. England and Wales show the smallest decrease in population for the last decade of any decade of the century.

THE JOHNSTON CURRENT BREAKER for rendering trolley or lighting wires safe when broken was recently tested with much success at Richmond, Va. The device consists of two springs inclosed in a boat-shaped receptacle, which are placed at intervals along the trolley wire and at points where the feed wires come in. These divide the wire into sections. When the line is intact the springs are expanded, the contact between the twin springs perfect and the current continuous. Cut the wire at any point on any section, however, and the inside springs of that section immediately contract, disconnecting them from the other 2 sections as well as from the feed wire, and rendering the trolley wire perfectly dead and harmless. At the same time the sections to the right and left of the cut wire remain fully charged.

A trolley wire was cut by a lineman just after the trolley of a car had passed under it. The car stopped

almost immediately, and Mr. A. Langstaff Johnston, the inventor of the device, picked up both ends of the cut wire, showing it to be absolutely dead. A second experiment had the same result.

LANCES MADE OF MANNESMANN TUBES are the latest application of this process. At the funeral of Count von MOLTKE, says the *Ironmonger*, some of the troops were equipped with lances the shafts of which were made of very thin steel Mannesmann tubes. They were lighter than the wooden shafts, and yet stronger and more elastic.

PERSONALS.

Prof. WILLIAM E. WEBER, the German electro-scientist, died recently at Gottingen, at the age of 87.

Mr. H. A. SUMNER has been appointed Chief Engineer of the Denver, Apex & Western Ry., at Denver, Col.

Mr. W. A. LASH, of Walnut Grove, N. C., has been elected President of the Cape Fear & Yadkin Valley R. R.

Mr. G. W. KITTRIDGE has been appointed Chief Engineer of the Cleveland, Cincinnati, Chicago & St. Louis R. R.

Mr. E. T. MCCONNELL, of Indianapolis, Ind., has been appointed Engineer of Maintenance of Way of the Peoria & Eastern R. R.

Mr. WM. H. BALDWIN, JR., has been appointed General Manager of the Flint & Pere Marquette R. R., vice Mr. H. C. POTTER, resigned.

Gen. A. G. BLANCHARD, who died at New Orleans, La., June 21, was City Surveyor of New Orleans and State Surveyor of Louisiana in 1855.

Mr. GEO. S. RICE, Deputy Chief Engineer of the new Croton Aqueduct, has been appointed Chief Engineer of the Rapid Transit Commission, Boston, Mass.

Mr. RUDOLPH HERING, the well-known sanitary and hydraulic engineer, sailed for Europe on July 2 to study the latest practice in sewage disposal, etc., in various European cities.

Mr. L. Y. SCHERMERHORN, U. S. Assistant Engineer under Col. ROBERTS, U. S. Engineer Corps, Philadelphia, Pa., has resigned, to accept the position of President of the American Dredging Co. He is the author of the index to the Reports of the Chief of Engineers.

Mr. J. H. DECKER, of Salina, Kan., has resigned his position as Secretary, Treasurer and Superintendent of the Salina Water Works Co. and the Winfield Water Co., and has accepted a position in charge of a department af the pumping engine business of H. R. WORTHINGTON, New York.

Mr. JAMES K. GEDDES, M. Am. Soc. C. E., has been appointed General Manager of the Bellaire, Zanesville & Cincinnati Ry., vice Mr. W. R. CRUMPTON, resigned to accept service with another company. Mr. GEDDES will continue as Chief Engineer, and will have his office at Zanesville, O.

Mr. JOSIAH PIERCE, JR., Assoc. M. Inst. C. E., has opened an office as civil and topographic engineer at No. 11 South St., Baltimore, Md. Mr. PIERCE has had long experience in the Northern Transcontinental Survey, the U. S. Geodetic Survey, and the U. S. Geological Survey, and was U. S. Assistant Engineer of Irrigation.

Count CHARLES A. FESTSTITS, Chief Engineer of the Alabama Coal & Iron Co., died in Jersey City, N. J., June 26. He was a native of Hungary, and came to America about 1865. One of his earliest positions here was that of Constructing Engineer on the Texas & Pacific Ry. In 1868 and 1869 he was first assistant to the late Gen. CHARLES P. STONE, engineer in charge of the survey for the Florida Ship Canal, and he personally surveyed the route. In 1872 he was in charge of the laying of the double track for the New York Central & Hudson River R. R. from Buffalo to Albany. He was for some time connected with the Cornell Iron Works of this city, and was assistant to Gen. STONE, in the erection of the Statue of Liberty in New York Harbor. He was also assistant to Gen. GEORGE B. MCCLELLAN when the latter was Chief Engineer of the Dock Department.

Prof. MARK W. HARRINGTON, of the University of Michigan, at Ann Arbor, succeeds Gen. GREELY as Chief of the Weather Bureau, now transferred to the Department of Agriculture. Prof. HARRINGTON is about 43 years old, and has been professor of astronomy in the university named and editor of the *American Meteorological Journal*. He is regarded as an accomplished student of meteorological and climatic problems. He graduated in 1868 at the University of Michigan, and in 1871 was astronomical aid of the U. S. Coast Survey in Alaska. He then returned to Ann Arbor as instructor in biology. In 1876 he pursued his studies in Germany, and was later, for two years, professor of astronomy and mathematics in the School of the Chinese Foreign Office at Pekin. He was for a short time professor of biology in the Louisiana State University, and in 1879 returned and took the professorat Ann Arbor, which he last held.

NEW PUBLICATIONS.

July Magazines.—Harper's for July has no technical papers. To those interested in South America, however, which includes, we believe, very many engineers, THEODORE CHILD's paper on Paraguay will be of interest. The greatest drawback to Paraguay, according to his description, is the Paraguayans, who find it so easy to live comfortably off the spontaneous productions of the country that they abhor work; and as aconsequence, enterprising foreigners who would invest capital in the development of the country's resources meet with little encouragement. A humorous little story, by THOMAS JANVIER, has for one of its characters a genial and artistically profande "tramway promoter," card sharper and general dead beat, whose like we fear is to be found in real life, although the type is certainly not a common one.

Scribner's has for its leading article a finely illustrated paper on "Speed in Ocean Steamers," by A. E. SEATON. So far as we have examined it, the historical portion of this paper is fairly accurate; but there are some serious errors in the technical portions. It is stated, for instance, that the "work done by a ship in moving forward is exactly equal to that of the water moving in the opposite direction," when the ship is under way; also that the tendency in stationary steam engineering "is to substitute gas for solid fuel or to use the coke resulting from gas manufacture." Criticisms might be made on many other statements as well as on the arrangement and general style of the article, which is hardly up to the mark set by previous technical articles in this magazine. It is really a difficult task, however, to make technical subjects interesting and intelligible to the general reader; and credit should be given the author for the work which he has done, although his statements should be accepted with caution.

Another article entitled "Training a Tropic Current: an Engineer's Glimpse of Hayti," contains less matter of technical interest than would be judged from its title. After describing the causes of the floods which have at times done great injury to the city of Cayes, the author says that "to detail the method by which it is proposed to control the future floods and lead them harmless to the sea would be too technical for these pages." He then gives a brief and interesting description of Hayti, a country whose worst foes are its own people, and whose immediate prospects of prosperity are rather discouraging.

The Century does well in its choice of the most important article for the current month, whose title it prints on the outside cover. It is "Paris; The Typical Modern City," by Dr. ALBERT SHAW, of Minneapolis, the well-known economist. It is a description of the municipal methods employed in that great and well managed metropolis. Every one intrusted with responsibility in an American municipality, and every thinking citizen as well, should read this article, especially that describing the systems of lighting employed. The key to the whole success of Parisian municipal administration is the practical appreciation of the fact that public office is a public trust, and that municipal franchises of every sort are the property of the people, and should only be given to private companies where an equitable return is made.

A brief paper entitled "A Lunar Landscape," by EDWARD L. HOLDEN, is illustrated by two fine engravings showing photographs of the moon's surface taken at the Lick Observatory. An "open letter" on the disputed boundary between Alaska and British Columbia, gives some information on a subject which has been little discussed in the United States.

In The *Popular Science Monthly*, Mr. S. N. D. NORTH's article on the development of the industry of wool spinning and weaving is continued, or concluded, there is no means of telling which. Our criticism last month that the modern development of the industry was hardly touched upon, was based on the supposition that the paper was complete in that number. We are glad to heartily commend the author's description of the evolution of modern textile machinery in this number. It is thoroughly well written and should be of interest to every engineer. Some of the greatest triumphs of mechanical ingenuity have been achieved in textile machinery; but little is known of them by engineers not connected with the work. This article is of more value and interest than all the rest of the number.

A word of praise must be given, however, to an article by Gen. EMMONS CLARK on "Sanitary Improvement in New York During the Last Twenty-five Years," by which the death rate per 1,000, which was 33.06 per year in the decade from 1851 to 1860, was decreased to 25.54 in 1886-90. "The only important particular in which no sanitary improvement has been visible," says the author, "is in the cleanliness [? ED.] of the streets, and in the removal of the ashes and garbage of the city." Another article which may have some claims on the interest of engineers is a brief account of the development of agricultural experiment stations in this country.

There are some interesting articles in the *North American Review*, though it can hardly be said that any question of engineering interest is touched. ERASTUS WIMAN's paper, entitled "The Farmer on Top," is an ingenious enlargement on C. WOOD DAVIS' theory that the unoccupied arable lands of the United States are about gone, and that an era of high prices for farm products and farm lands is about to begin. With a truly colossal disregard of economic principles, Mr. WIMAN figures out that this supposed approaching scarcity in the food product of the United States is going to be a great boon to the whole country, as well as to the farmers, and will cause a new era of prosperity. Unfortunately for the country, it is to be feared that the facts which Mr. WIMAN cites are more nearly correct than the sanguine theory of their results with which he closes.

In an article on "Industrial and Financial Corporation," Mr. F. B. THURBER, of the Thurber-Whyland Co., takes occasion to praise the safety of investments in the stock of mercantile or manufacturing companies and in the various trusts as compared with railway investments. He would have done well to add that the stock of no company is a safe investment unless the stockholders as a body take interest enough in the property to see that it is properly managed. This is a matter in which English investors as a class are much in advance of American.

The *Forum* has a most excellent article by Hon. ALDACE F. WALKER, Chairman of the Western Traffic Association, on "The Operation of the Interstate Commerce Law." He points out again the truth concerning it which people find so hard to understand—that it is impossible to stimulate competition and restrict it at the same time, as the law attempts to do. The result of the attempt has been the absorption of small roads by the larger; and unless the law is amended to permit some form of pooling, consolidation is bound to go on still more rapidly.

Another paper of interest, by Gen. THOS. JORDAN, formerly Commander-in-Chief of the insurgent forces in the Cuban insurrection, gives an account of the natural resources of that fertile island and advocates its annexation to the United States.

—The Arithmetic of Electricity. A Manual of Electrical Calculations by Arithmetical Methods. By T. O'CONOR SLOANE, Ph. D. New York: N. W. Henley & Co. Cloth, 12mo, pp. 138, cuts. $1.

An elementary book on the methods of calculating the proper size of wires, the proportions of dynamos and motors, the arrangement of battery cells, and similar details of electrical apparatus has long been wanted. While a work of this nature, prepared by Professor DAY, of London, has already met with a deservedly large sale, Dr. SLOANE's book has, we believe, no other prototype. It certainly deserves a wide circulation, and can be used to great advantage in connection with any of the recently issued popular books on electricity, the great fault of which is their failure to describe the methods of computing electrical quantities.

Improved Roads.—Pamphlet, pp. 50.

An address by CHAUNCEY B. RIPLEY, L. L. D., delivered before the New Jersey State Board of Agriculture, and a reprint of a series of interviews with Mr. RIPLEY, published at various times in the *New York Times*. It contains considerable interesting information regarding road making in Union Co. and other parts of New Jersey.

—Hendricks' Architects and Builders' Guide and Contractors' Reference Directory of America for Builders-Contractors, Manufacturers and Dealers in all kinds of, building supplies. S. E. Hendricks & Co., New York. Cloth, 10½ × 7 ins., pp. 490.

This book is a trade directory, the scope of which is sufficiently described by its title. It is well printed and apparently about as complete and reliable as such a book can be, but considering the number of changes in business deaths, etc., it is practically impossible to get up a thoroughly reliable directory. Engineers and contractors are included in the list.

SOCIETY PROCEEDINGS.

Northwestern Society of Engineers.—This society has been organized at Seattle, Wash. President, G. W. Cott; Vice-President, F. W. D. Holbrook; Secretary, Edwin H. Warner; Treasurer, M. Stixrud; Librarian, T. A. Noble; Directors, W. P. Watson and J. T. Pratt.

Engineers' Club of Minneapolis.—At the meeting on June 4, Mr. O. Hoff spoke upon "Bridge Erection," calling attention to the fact that by not duly considering the matter of erection, very often details were so designed as to cost a great deal of money in putting up the structures in the field. He claimed that all couplings should have plenty of play, and field riveting be reduced to a minimum. It pays to waste iron in designing details by the saving on easy and quick erection. Temporary structure for erection should be figured with a factor of 3 to 4; new manilla rope with 4, and old manilla rope with 5. Mr. Hoff then mentioned a traveler he is using at present to erect the Belt Line Bridge at Minneapolis. It has a reach of 90 ft., so as to erect a 60-ft. span and a 30-ft tower without moving on. The total weight is 75,000 lbs. and its cost $1,050. A counter weight of 13,400 lbs. was necessary, and was furnished by engine and boiler, weighing 20 tons in working order.

ENGINEERING NEWS

AND

AMERICAN RAILWAY JOURNAL.

Published Weekly at Tribune Building, New York.

Vol. XXVI. Saturday, July 4, 1891.

D. McC. STAUFFER, A. M. WELLINGTON.....EDITORS
CHAS. W. BAKER, E. E. R. TRATMAN, M. N. BAKER, F. P. BURT, } ASSOCIATE EDITORS
GEO. H. FROST.....BUSINESS MANAGER

IMPORTANT TO SUBSCRIBERS.

Hereafter we will not accept a subscription to this journal from subscription agents or from anybody else at less than our published rates. No club rate or commission will be allowed. Newsdealers must send their orders to the American News Company. This policy is one of necessity. We spare neither money nor labor in the effort to produce the very best of engineering newspapers, and in justice to ourselves and to all of our subscribers we must have our full rate every time.

We shall be obliged if subscribers will deal with us direct, and it will be a favor also if they will use a printed letter-head or inclose a professional card for classification purposes; it will be of advantage to them also.

ENGINEERING NEWS PUBLISHING CO.

July 4, 1891.

Subscription Rates: *One Year,* **$5.00;** *6 months,* **$2.50;** *4 months,* **$2.00;** *Single Copies,* 15 *cents. To all* **Foreign Countries** *in the Postal Union, add $3.08 to above prices for postage. Subscribers can have the mailing address of their paper changed as often as they desire. Send both the old and the new addresses.*

The date *when the subscription expires is on the address label on each paper, the change of which to a subsequent date becomes a receipt for remittance* **No other receipt** *is sent unless requested.*

Advertising rates, 20 cents per line *agate measure. Schedule sent on request.* **Changes** *of advertisements must be in hand on Tuesday afternoon;* **New** *advertisements Wednesday afternoon;* **Transient** *advertisements not later than Thursday noon. The last pages go to press early on Friday, and we shall be obliged if subscribers who fail to receive their papers promptly will notify us without delay.*

Drawings and Photographs *of all new engineering works or designs, large or small, of interest from their magnitude, novelty, or originality, as well as newly adopted* **Standard Plans** *for engineering structures or details, rolling stock, etc., are always desired for early publication. Also* **Brief Technical Notes** *of the cost or manner of executing work, tests of materials, machines or other new devices, and* **News of New Construction** *of all kinds.* **Letters** *for publication must be accompanied by the name or card of the writer.*

COMING TECHNICAL MEETINGS.

Technical Society of the Pacific Coast.—July 4. Secy., O. von Geldern, 519 Market St., San Francisco.

Civil Engineers' Society of St. Paul.—July 6. Secy., C. L. Annan.

Civil Engineers' Association of Kansas.—July 8. Secy., J. C. Herring, Wyonita, Kan.

Engineering Association of the South.—July 9. Secy., Olin H. Landreth, Vanderbilt University, Nashville, Tenn.

Engineers' Club of Kansas City.—July 13. Rooms, Baird Building. Secy., H. Goldmark.

Atlanta Society of Civil Engineers.—July 14. Secy., Parker N. Black, 39 Capitol Block.

Civil Engineers' Club of Cleveland.—July 14. Secy., A. H. Porter, 50 Euclid Ave.

Engineers' Club of St. Louis.—July 15. Secy., Arthur Thatcher, Room 801, Odd Fellows' Building.

Engineers' Club of Cincinnati.—July 16. Secy., J. F. Wilson.

Engineers' Society of Western Pennsylvania.—July 21. Secy., J. H. Harlow, Pittsburg, Pa.

Denver Society of Civil Engineers.—July 23. "Canals and Irrigation." Secy., Geo. H. Angell.

Western Society of Engineers.—Aug. 5. Secy., J. W. Weston, 280 La Salle St., Chicago.

Engineers' Club of Minneapolis.—Aug. 6. Rooms, Public Library Bldg. Secy., F. W. Cappelen.

Association of Civil Engineers of Dallas.—Aug. 7. Secy., E. K. Smoot, 803 Commerce St.

Correspondents who consider themselves ill used if their communication is not published exactly as they wrote it, and firms which aim at free advertising in sending items of news interesting only to themselves and their competitors, may find a moral in the following, clipped from the last issue of *The Engineer*:

ROCK ASPHALTE.

SIR,—We beg to mention that we are now paving with Brunswick rock asphalte the new stables just purchased by his Grace the Duke of Wellington in Kelton mews, Knightsbridge, and the same will be occupied by his Grace as soon as completed.

BRUNSWICK ROCK ASPHALTE PAVING COMPANY,
9, Gracechurch-street, E. C., June 11th.

[We hope his Grace will be comfortable.—ED. E.]

We venture to guess that "his Grace" would be more comfortable than was the writer of the above letter when he saw it in print.

THE diagrams accompanying Prof. THURSTON'S paper on "Steam Engine Efficiencies," published in another column, will repay careful study by those interested in thermodynamic problems or in the development of motors other than the steam engine. An impressive feature is that the efficiency of the ideally perfect engine, working under the best practicable conditions of high steam pressure and high ratios of expansion, is not so much above the results obtained in the best modern practice in steam engineering as we are apt to think. The best pumping engines, marine engines, and stationary mill engines are to-day giving records which are not very far below the limit beyond which no improvement in the economical use of steam to drive a piston in a cylinder is possible. Those who would try to improve on the best steam-engine practice of the present day must understand that no such opportunity exists for increasing the fuel economy of the steam engine now as existed forty years, or even twenty years ago, although there is certainly plenty of room for work in bringing the average steam engine in daily service up to the standard set by the most economical engines now running.

IN saying this, however, it should not be understood as a prophecy that great improvements in the economical generation of power from fuel are not in store. Indeed, the realization of the fact that the development of the steam engine has reached a point where further gains in economy cannot be great, will stimulate the search for a more economical motor. Perhaps the most promising direction in which to look for a more efficient motor is in the combustion of the fuel directly in the engine cylinder, as is now done in the gas engine. Gas engines of sizes up to 100 HP. are already on the market guaranteed to give a fuel economy equal to the best triple-expansion marine steam engines. It is pretty well known that the theoretical limit of economy is much higher in the gas engine than in the steam engine. Another motor whose theoretical chances are promising is the hot-air engine. The great obstacle met in its development has been the large weight and bulk required for a small power; but ways may yet be devised for reducing this. Some electrical inventors are laboring on the problem of producing electricity directly by the combustion of coal, but, so far as we know, their progress has not been encouraging. Still, the possibilities in this direction are very tantalizing, and they are likely to be pretty thoroughly explored.

In steam engineering, it is likely that the heat losses in the furnace and boiler, which have been somewhat neglected while the engine has been in process of perfection, will be more carefully looked after. Such heat from boiler and engine as must inevitably be discharged as heat will be utilized in that form whenever possible. Wherever the heat of the exhaust steam and the chimney gases can be profitably utilized, the steam engine can apparently hold its own against any form of prime mover: for it is difficult to believe that in convenience, reliability and general adaptation to all places and uses any new form of motor can equal the steam engine.

THE recent failure of a cast-iron bridge girder on the London, Brighton & South Coast Ry. in England has been investigated by an inspector of the Board of Trade; and his report, which is abstracted in another column, must be interesting reading for those British engineers who have a sharp eye for faults in American bridge practice, although, as nearly as can be judged, he has not half done justice to the case before him.

American engineers, and Americans who could lay no claim to the title of engineer, have built some bridges in the past which deserved criticism, and received it, too. But as knowledge has increased, many errors have been rectified, and great improvements have been made. Not all American railway bridges are what they should be by any means; but on our principal lines at least we believe that no bridge is kept in use without some sort of knowledge of its strength; and we doubt if there is a single bridge on an important American railway as treacherous as was this ill-designed cast-iron structure on one of the principal railways of England, the failure of which is remarkable chiefly because it did not occur many years ago.

To give a clearer idea of this choice specimen of the bridge builder's art, we print on another page a sketch, showing the cross-section of one of the cast-iron girders, according to the dimensions given by the Board of Trade's inspector. The dimensions of the top flange are not given, but it is not important, since failure did not occur there, and all the metal put into the top flange above what was needed made the beam so much weaker.

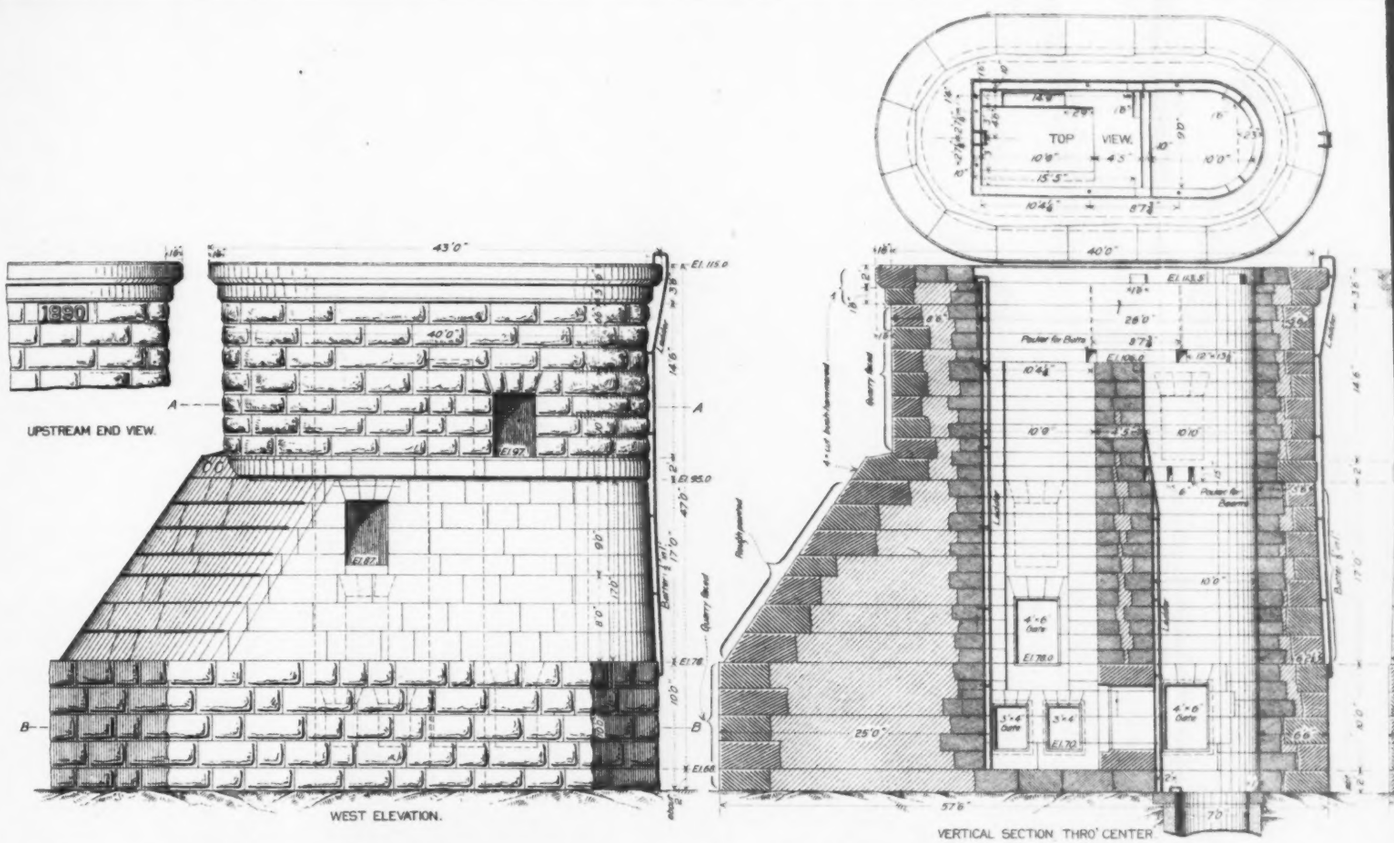
On the inner bottom flanges of these girders at intervals of 3 ft. were placed cross-beams 5 ins. deep and 8 ins. broad, and on these were placed the stringers, ties and rails. It is plain from this that every train over the road for the past 30 years has been carried by two girders of 26½ ft. span, of the form shown in the sketch referred to. Each girder, it is seen, stood for itself, and had no aid from the girders supporting the parallel tracks on either side. Hence the breakage of any girder meant a wrecked train.

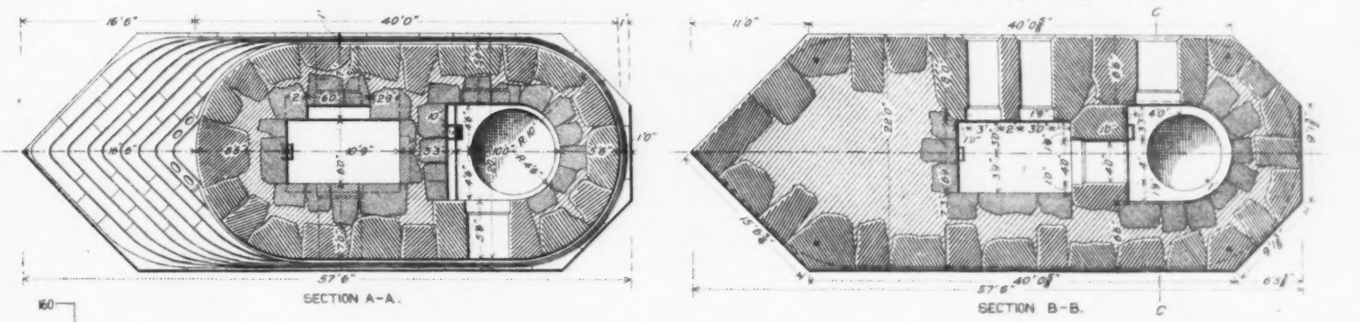
IT need hardly be said that these girders were greatly weakened by the unsymmetrical bottom flange. When the beam was deflected the much greater resistance of that part of the lower flange shown to the right of the web of the beam in the sketch would not only increase the tensile strain in the narrow flange on the other side, but in doing so would tend to bend the beam in a horizontal plane and increase still further the tensile strain on the narrow bit of cast iron. Major HUTCHINSON, the Board of Trade inspector, says: "The calculated breaking load of this girder, according to the usual rule, would be about 71 tons."

Just what the "usual rule" referred to is, we do not know. It is hardly possible that cast-iron beams with three-fourths of the lower flange on one side are so common in England that they have a "usual rule" for calculating their strength. We strongly suspect, however, that Major HUTCHINSON calculated the strength of this girder as if the lower flange were symmetrical, and that the "usual rule" referred to is that found on page 518 of TRAUTWINE'S pocketbook, which is:

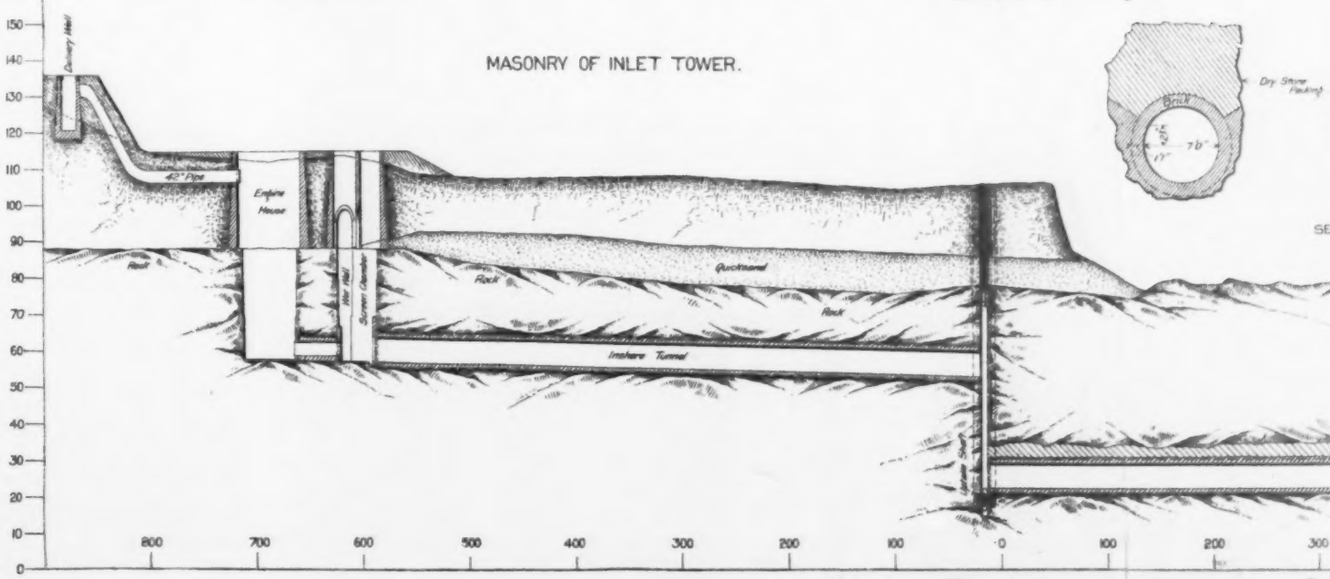
To find the size of a Hodgkinson cast iron beam required to break under a given center load, having the depth: Multiply the given load, in tons of 2,000 lbs., by the clear span in feet. Multiply the constant 2.166 by the total depth of the beam in inches. Divide the first product by the last and the quotient will be the area in square inches necessary for the lower flange of the beam.

According to this rule, the lower flange of a symmetrical girder, of the given span and depth, to support the breaking load given by Major HUTCH-





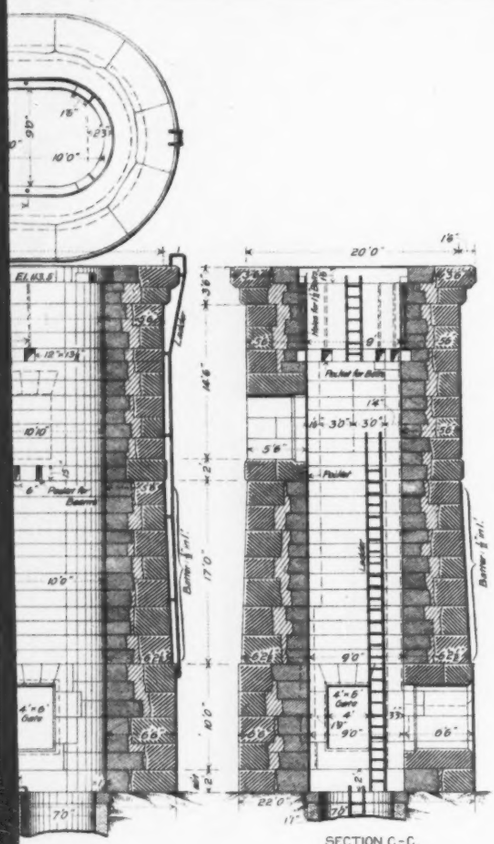
MASONRY OF INLET TOWER.



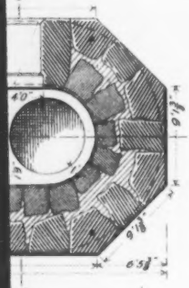
INLET TOWER AND TUNNEL, St

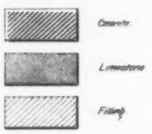
S. BENT RUSSELL, PRIN. ASST. ENGINEER.

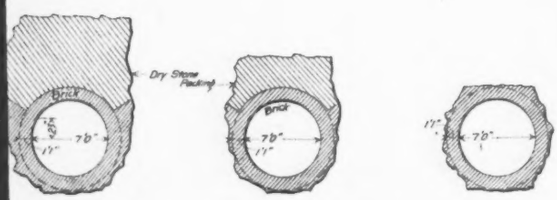
M. L. HOLMA



SECTION C-C.

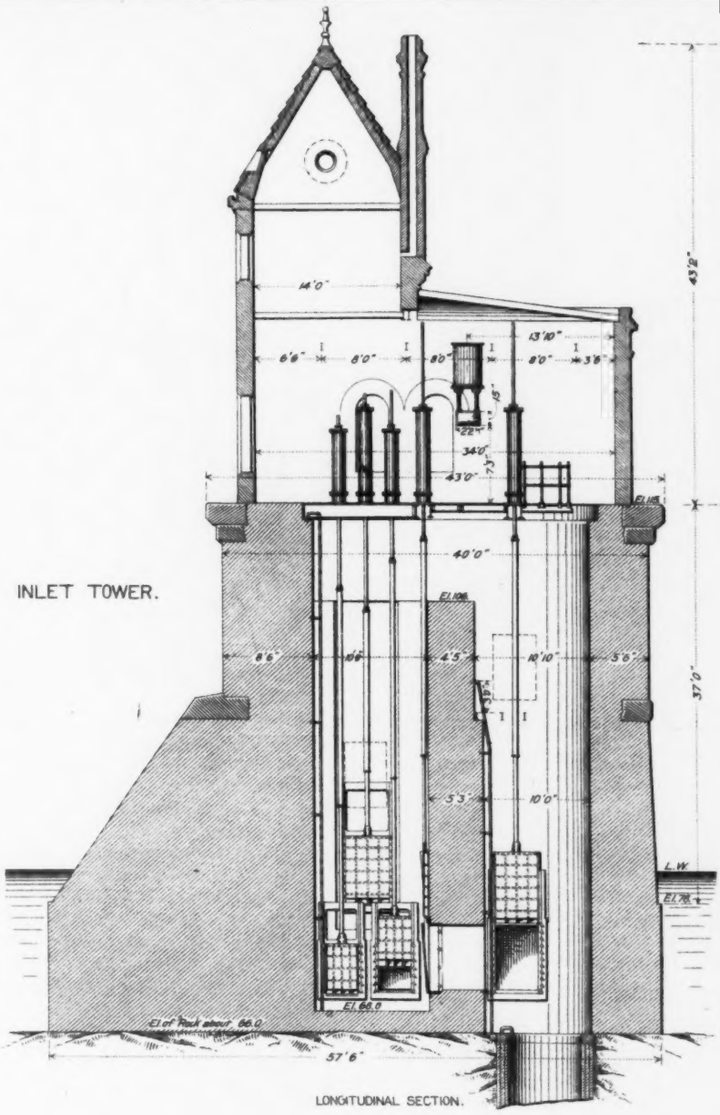




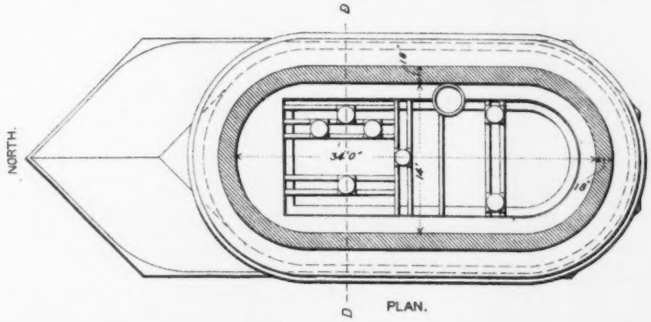


SECTIONS THROUGH TUNNEL.

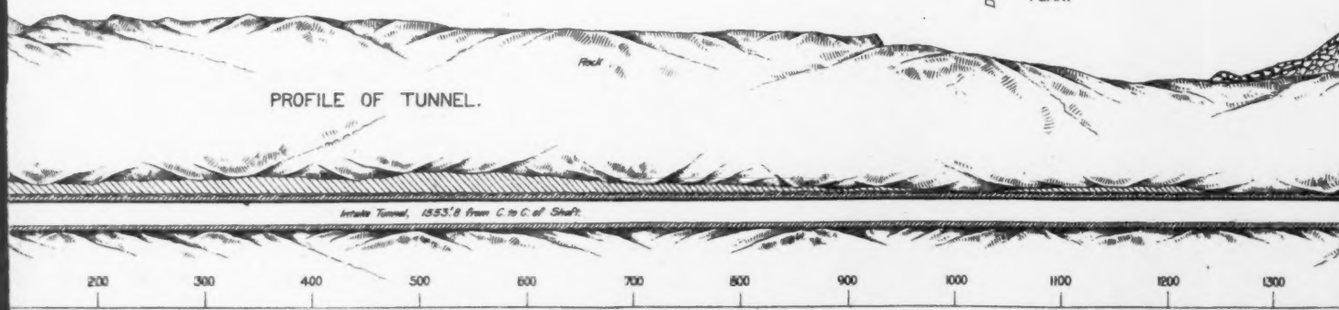
INLET TOWER.



LONGITUDINAL SECTION.



PLAN.

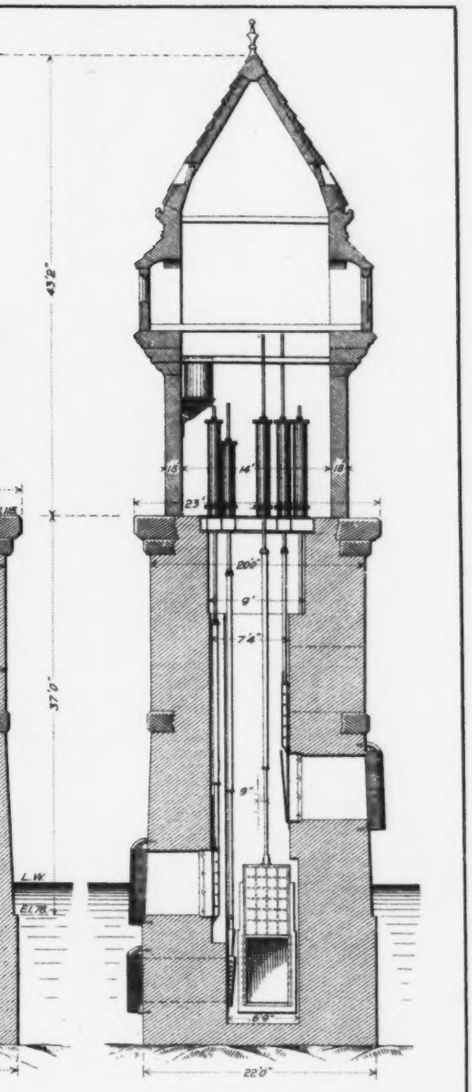


PROFILE OF TUNNEL.

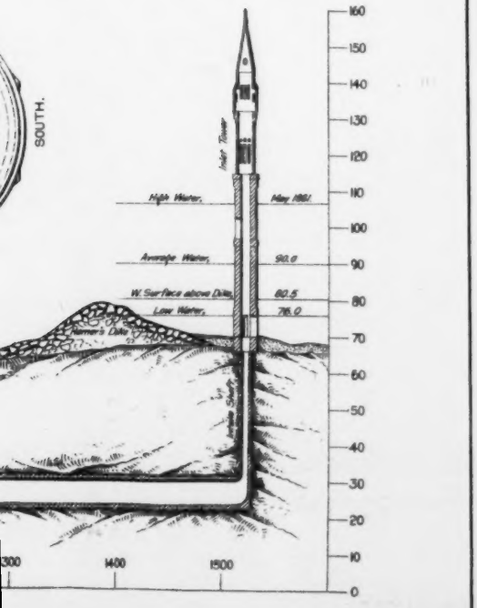
TUNNEL, ST. LOUIS WATER-WORKS EXTENSION.

M. L. HOLMAN, WATER COMMISSIONER.

R. P. MCCORMICK & CO., CONTRACTORS.



CROSS SECTION D-D,
LOOKING SOUTH.



LITH. CHAS. HART & SONS, 32 VESEY ST., N. Y.

INSON corresponds closely to the lower flange of the girder under discussion. Perhaps if the Board of Trade would re-examine this matter they would find even more potent reasons to offer to the railway company for abolishing cast-iron girders than those given by their inspector. The report states that there are "only five cast-iron girder bridges on the main line between London and Brighton." If they are of the same diabolical design as the girders of the bridge at Norwood Junction, there are just five too many.

INDEED, whatever their design, the fact that they are of cast-iron should be enough to condemn them forthwith. The failure of the girder in the Norwood Junction bridge started at a flaw which is described by Major HUTCHINSON as being about 10 ins. long and an inch wide, a portion of it in the narrow side of the bottom flange. The superintendent of the road stated just after the accident that it occurred "on account of a latent flaw which could not have been discovered." It is to be hoped that he will heed the obvious moral and replace his cast-iron bridges with some material which cannot conceal flaws of this somewhat objectionable size. Otherwise the sense of happy security with which the British traveler is supposed to roll along may again be rudely jarred.

Of course no one thinks of using cast iron for bridge girders nowadays. American engineers, when obliged to use cheap materials, have had cheap and abundant timber at hand, so that there has been no occasion to use cast iron in this country in places for which it was wholly unsuited; and while wood has its faults, its greater resilience under shock and its less liability to hidden defects make it a much safer material than cast iron.

Electric Currents vs. Mine Ventilation.

The advantages to be gained from the use of the electric current in mining operations are many and are now fully recognized. By it better light can be secured and danger points be watched more closely, power can be conveyed economically to distant parts of the mine, motors can be used for hauling out the product or the same power used in cutting out the coal, and in many ways the new source of light and power can be utilized. The one, and probably the only serious drawback is the danger of explosions in gassy mines; for it is alleged by Mr. THOMAS SHAW, in his writings on this head, that the silent current passing along a wire is alone sufficient to fire a gas that has within it the proper admixture of explosive elements. Consequently, the slightest spark at the "cut-out" of an electric light in a mine subject to these conditions would be dangerous; and mines known as gassy mines are very generally shunned by all electric companies dealing in mining appliances.

The dangerous gases in mining coal, in both anthracite and bituminous regions and in all countries, are identical in their character. In all cases, when a coal seam is opened either by blasting or "a fall of roof," carbureted hydrogen at once exudes in greater or less volume. The miners and bosses become accustomed to the presence of this gas to such an extent that they grow careless and indifferent, and it is a too frequent occurrence for a miner to raise his lamp to the roof, and firing the gas, watch it burn slowly along the roof until it is consumed. It may or it may not explode, and he cannot tell until he tries it, for with the addition of from 4 to 12 volumes of atmospheric air, depending on the character of the coal giving out the gas, it will explode: above or below these proportions it is only inflammable. But in this operation the miner unwittingly produces the other gas known as "choke-damp," which is a carbonic oxide incapable of supporting life, and has a specific gravity sufficiently great to cause it to fall to the floor of the drift or gallery, and there remain in a dense stratum until forced away by the pressure of air or another explosion.

This carbonic oxide, known to chemists as CO_2, is incapable of supporting combustion, and if the wires carrying electric currents were kept at the bottom, in a constant atmosphere of this kind, they would cause no trouble. But the lighter and more dangerous gas stratifies by natural levitation, and when it meets with the proper conditions is ready to explode. This condition is, as above stated, a proper admixture of atmospheric air, and other conditions being equal, it only needs a very small spark from the wire to cause most serious damage.

One remedy for the condition of affairs here referred to is little more than hinted at in the letter of Mr. QUACKENBOSS, elsewhere published in this issue. But this hint means revolution in the present practice of mine ventilation, and is likely to stir up a considerable controversy among mining experts. The interesting point in this letter is the suggestion that the forcing of dense, humid air into the mines, under the atmospheric conditions referred to, may add the very element of hydrogen that is needed to bring about a disastrous explosion. The comparison of mining disasters with prevailing atmospheric conditions, made in the letter, is certainly a striking coincidence, if not convincing proof of the assumption that humidity adds to the dangers present.

In the valuable report of Her Majesty's Commissioners on Accidents in Mines, presented to the English Parliament in 1886, there is much material bearing upon the proper ventilation of mines and the dangerous conditions to be guarded against. Referring to the effect of variations of atmospheric pressure on a fiery mine, the Commissioners say that wherever gas has accumulated in old workings there can be no question that its dilatation consequent upon a reduction of atmospheric pressure is liable to produce a dangerous state of affairs. Where a large range of cavities communicates with a narrow passage, many yards of the latter may be fouled by even a very small expansion of the gas; and the air in such a passage may be in a very dangerous condition before any fall in the barometer has been detected. In other words, experiments show that a "goaf" of only one acre in area, and with an average height of 3 ft., will send out about 44 cu. ft. of gas for a fall of pressure represented by only 0.01 in. of mercury, which would not be perceptible on an ordinary barometer. Owing to these circumstances the Commission does not place much confidence in the establishment of special and additional observatories for warning miners of approaching atmospheric changes; and fears that the official dissemination of such warnings would lead to an exaggerated estimate of their value, and a false sense of security that would cause the miner to relax his ordinary vigilance.

This Commission states that there is a great difference in this respect between mines that are artificially ventilated and those in which natural ventilation is alone relied upon. Under the latter condition it needs no argument to show that the air in the mine must be seriously affected by atmospheric changes, and that barometric, thermometric and hygrometric phenomena must be taken into account in estimating the present and impending state of the air in the mine workings. But it would also seem to us that much of this latter precaution would apply to artificial ventilation as well, when the air which was being forced into the mine in large volume and by powerful machinery was of a nature that would add the dangerous element of hydrogen to existing conditions that perhaps lack only this one element to bring about an explosion. If variations of pressure so slight as not to be noticed on an ordinary barometer can do harm, by allowing an expansion of stored gas under conditions adding to the dangerous elements in the gas itself, there seems to be only one safe method of proceeding, and that is to remove the gas as fast as it accumulates by special pipes and by powerful special exhausting apparatus. This is opposed to the usually accepted practice, we know, and means a radical change in the present ventilating plant; but in the light of modern appliances, and the possibility of introducing electric power under safe conditions, the experiment is worth study and trial.

It is admitted that a very large proportion of mining accidents is due to the sudden intrusion of gas from the strata into the workings, generally in moderate quantity, but capable, especially in the presence of coal dust, of originating under certain circumstances an explosion of the worst character. This intrusion may follow a fall of roof, visible movements of the strata, or, as suggested by the Commission referred to, earth shakes or tremors, which only the most delicate apparatus would reveal. The latter phenomenon would account for a number of explosions at short intervals of time in distant places, and the Commission thinks that observations of such tremors at a few scattered stations might furnish useful information.

It is generally assumed that the only method of avoiding explosions in dangerous mines is to employ lamps and machinery for coal extraction that could not ignite gas if it were present. This would apparently preclude the use of electricity, but it seems to be forgotten that as a conveyor of power and as a motor for exhaust fans the electric current could be made to secure a safe passage for itself. Gas may burn when diluted with air, but can only explode under certain fixed proportions of air and gas; and with a fan at the danger point and pipes leading from this point to the outer air, there should be practically an end to the gas strata in high points in the workings that usually exist there even in the best present practice, and that threaten danger by awaiting the proper additional explosive elements. By the forcing system of ventilation used by some miners, the foul air can certainly be displaced, but it is not removed with any certainty: and if it lurks anywhere inside the mine the conditions for explosion may be at any time reached and its accidental ignition will usually affect other accumulations of gas and result in a formidable explosion.

The usual ventilating practice in this and other countries is confined practically to exhausting or deminishing the pressure in the upcast shaft; but it does not go to the extent of extending this exhaust to the points of immediate danger. The reason for this is plain, if pipes alone are to be depended upon; but the possibilities of power transmission by the electric current and modern electrical apparatus enable the engineer to place the exhausting fan in a position for certain work, and at the point where otherwise the gas would accumulate. A simple pipe leading to that point, as part of an intricate system of exhaust pipes leading to one fan is evidently not a sure means of extraction. Electrical science has advanced more rapidly than any one branch of scientific knowledge, and the early dynamos and motors, of even 10 years ago, are comparatively crude machines alongside of those of later introduction. While it is admitted that these earlier forms were dangerous under the mining conditions referred to, and that even the latest would be dangerous in an improperly ventilated mine, electrical engineers now stand ready to utilize this new source of power transmission in ventilating as well as in lighting and working mines. Aside from economy in labor performed is the still greater gain in safety to human life in removing at once a source of constant danger. To do this on the lines laid down means money expended in honest, persistent experiment and the upsetting of some pet theories, perhaps: but the prospective gain is sufficient to warrant the outlay of the one and the casting aside of the other.

English and American Railways.

The investigation of English railways which has formed the basis of the series of articles on the construction and equipment of English railways, published in the first volume of this year, has made apparent an important fact which is, perhaps, not generally realized. This fact is that English and American railways, commenced and developed under such radically different conditions, are tending toward a common standard, while the differences in matters of detail, which have been considered as the special features of railways on one side or the other of the Atlantic, are becoming fewer and fewer as the railway men of one country become better acquainted with the work of those of the other.

Beginning with the promotion of railways, let us consider the methods of obtaining charters or legislative acts. In England an Act of Parliament has to be obtained, involving tedious and costly proceedings. A large amount of preliminary engineering and legal work has to be done, numerous rigid regulations have to be complied with, and petty details to be attended to, in order to insure the application coming before the parliamentary committees for consideration, while the application has then to be fought through against the opposition of rival or competing lines, property owners, and others. If successful, a certain percentage on the estimate has to be deposited with the government as a bond to insure the carrying out of the work. The course of these proceedings has been described in a paper by Mr. E. E. R. TRATMAN on "English Railway Legislation," published in ENGINEERING NEWS, Aug. 1, 1885. The English system is right in principle, and is adapted to that country, where there is already a vast network of railways and a comparatively narrow field for new railways, as it prevents the promotion of wildcat or speculative schemes. On the other hand, the expense obliged to be incurred in the preliminary work is too great, considering the absolute uncertainty of success, depending as it does upon the adroit presentation of the case by the lawyers, upon the whims of the committees, and other unknown quantities. Should a bill be rejected for failure to comply with any of the numerous "red tape" requirements, or be defeated before the committee upon its merits, for however slight a reason, all this expense is a dead loss, and must be incurred again, if the bill is strong enough to be brought up at another session, while in any case there is a delay of at least a year, since the projects for each session must be submitted by a certain date before the opening of the session. In this country the obtaining of a charter has been in general, and still is to a large extent, a mere formality, and there has been practically free and unrestricted railway construction. This system has also been right under the conditions existing here until recently, as it permitted the rapid construction of railways for the development of the country, to the benefit of the community at large. As the traffic increased, however, especially between the great centers of commerce, various railways were projected and built to compete for this traffic, and this has led to the promotion of many wildcat schemes, the construction of parallel lines, and other speculative devices, with disastrous results in many cases. There is now a tendency toward greater restriction in the granting of charters, requiring projectors to prove to a Board of Railway Commissioners, or other constituted authorities, the public necessity and probable advantages of their line, and such a system is already in operation in Massachusetts. This is a wise movement, and in all probability some such system will eventually be adopted, and will be under the control of a department of the general government, to which the State Commissioners would report. In England the system, practically as above described, was in force at the time when the first railways were projected, but in that country there was a settled population, and a considerable traffic waiting to be provided for. In the United States, railways were built to carry people to form a center of population, or an agricultural district, which would eventually furnish a traffic for the railway. But these conditions are now practically changed, and restrictions are consequently required.

In regard to the construction works, in England the bridges, viaducts, tunnels, stations, city terminals, etc., are in general more substantial and constructed with greater view to permanence than in this country. Heavy iron bridges and viaducts over which trains may run at speed, masonry bridges and viaducts, elevated or depressed approaches through cities to avoid interference with street traffic, bridges instead of grade crossings, closely fenced tracks, large and handsome station buildings of brick and stone, are all features of standard English practice. In this country there are, even on our main lines, too many slight bridges, timber trestles, inadequate stations, and other defective features. These are results of lines beginning in a small way and growing up with the traffic to great importance, but content to patch their old garments instead of buying new ones, which is a natural result of the financial conditions and management. In this respect, however, the American railways are approaching the English standard. Heavier iron bridges, with solid floors to carry an unbroken continuity of roadbed, substantial masonry bridges, rearrangements of terminals, elimination of grade crossings and surface lines, and the construction of substantial and commodious stations, are among the improvements in daily progress. The progress is not as great as it should be, however, owing to the slowness of even the richest companies to provide funds for this purpose, so that the American railway engineer labors at a disadvantage in not possessing the money and authority of the English engineer.

Coming now to the question of track, it must be admitted that the English railways are, as a whole, far superior to those of America in substantial construction. The track of the American railway has been a by-word for lightness, and not without reason, for it has not been improved in anything like proportion to the growth of the traffic, and many of the accidents recorded from day to day are due to the fact that fast and heavy traffic is run over light track. The railway companies are largely to blame for this state of affairs, as they have grudged money for such work, which would be in the line of economy in maintenance and operation, while they have given it freely for improved rolling stock and equipment, and have thrown it away lavishly for rate wars and other matters of so-called "competition." But here, too, improvements are being made to provide a suitable track for the traffic. Heavier rails, improved fastenings and joints, tie plates and other track equipment are being laid: but the work is very slow compared with what there is to be done. Considering the heavy cars and heavy trains upon some of the light tracks of this country, which would frighten an English railway man, and the light cars and trains upon the English tracks, the number of accidents here appears smaller than might have been supposed. In point of fact, the English type of track is too substantial and too costly in proportion to the traffic, but it has been built without regard to expense, and of course insures an economy in maintenance on the trunk lines. On the lines of minor importance, however, the track is sometimes out of proportion to present or prospective traffic. The English track, with its heavy iron chairs and bull-head rails, the wooden "key" fastenings for which the weak point of the track as far as security and permanence are concerned, is not likely to be introduced in this country, for with heavy flange rails, good fastenings, etc., a track can be built at less cost which will have an ample margin of strength and be economical in maintenance. In this respect especially the American railway is working its own way toward the standard of perfection. The grade of track labor is higher in England than in this country. In the introduction of interlocking switches and signals, and of the absolute block system of operation, the English railways rank far above those of America. In England, practically the entire mileage of main lines is thus protected, enabling heavy traffic to be handled with safety and rapidity, while in this country the block system is applied mainly to busy sections of line approaching large cities. Where used on the open track it is almost invariably operated on the permissive block system, thus largely destroying its efficiency. The use of interlocking plant, however, is becoming more and more general for the protection of yards, junctions, grade crossings, terminals, etc. The automatic block system is in use to some extent in this country, and is looked upon with very much more favor than in England, where also the application of electricity, except as an auxiliary to the signal man, is in general disapproved of.

In regard to locomotives, a lengthy article might be devoted to the comparison of American and English practice. In this country there are a certain number of distinct types, classed according to the number and arrangements of the wheels, but with special features of design and detail introduced by the master mechanics or builders. This adoption of general types in no way limits improvement or individuality, and in fact this is one of the departments of American railway practice in which there is a very active and constant movement toward improvement, to effect economy in hauling heavy trains at a low rate of expense. In England there is a greater diversity of types of engines for the same kind of service, and a greater difference between the equipment of the several roads. The only standard English type may be said to be the freight engine, with six wheels, all coupled. Tank engines, usually with side tanks, are very generally used for local and suburban traffic, and for runs of up to 20 or 25 miles on main lines. In this country such engines have generally a tank at the back of the frame, and are used almost exclusively for local and suburban traffic. Engines with more than four driving wheels are not used in England for main line passenger service, while in this country engines with six driving wheels and a two-wheel or four-wheel leading truck are being extensively used to meet the increasing weight of express trains. On the other hand, for the fastest express service many English roads use engines with only a single pair of large driving wheels, and it is possible that such engines may be introduced here. It has already been proposed, and we believe the matter is under consideration, to try such engines for making fast long-distance runs with cars of much lighter weight than the ponderous palace cars now run in express service. The American "eight-wheel" type of engine (with four coupled driving wheels and a four-wheel leading truck) is now very extensively used in England, and its use is becoming more and more general. The differences in details of construction cannot be dealt with here. In this country bar frames, trucks, outside cylinders, steel fireboxes, equalizing levers and the ordinary valve gear are universal. In England plate frames and copper fireboxes are universally used, while there is considerable difference of opinion among the locomotive superintendents of the various roads as to the merits of inside and outside cylinders, "bogie" trucks (two-wheel trucks are not used) and rigid axles, and of equalizing levers, while radial valve gears are in quite extensive use. Compound locomotives are

being experimented with in both countries. In regard to the work done, it may be said that both passenger and freight trains average very much heavier here than in England.

In passenger rolling stock equipment American railways are unquestionably very far ahead of English railways. In no country in the world are so much money and skill employed in the construction, equipment and decoration of cars as in this country, and no country has cars approaching ours in comfort, convenience, luxury and artistic finish. The special cars used by the queen and royal family of England are in scarcely any respect equal to the best palace cars on our fast express trains, and are far surpassed by the cars owned by the presidents of the large railway corporations, some of which latter cars are undoubtedly the finest railway cars in existence. It is probable that the present compartment system of English cars will eventually be very much modified, and a more comfortable and convenient arrangement adopted. It is not probable, however, that development in this direction will lead to the adoption of cars entirely open, like the American standard passenger cars, a plan which has many objections. This remark applies rather to the ordinary cars than to parlor and other "special" classes of cars in which special conditions occur owing to the charging of extra fare. It is only within comparatively recent years that drawing-room, saloon, sleeping and other such cars have been run in England. Dining cars have also been introduced, but the lack of communication with the rest of the train is a drawback to their use. Many of the modern cars are carried on four- or six-wheel trucks, instead of upon the older system of rigid axles. Some of them are fitted with lavatory accommodation, but the arrangements are crude and defective, and they are not properly looked after. The cars having such accommodations are comparatively few, but the claim that they are not needed is not valid, as there is a considerable traffic in trains making but few stops. The heating and lighting are also very inefficient, and continuous automatic brakes are of comparatively recent date. English railway companies have had a passenger traffic ready to hand, and have not cared to devote much thought or money toward providing for the comfort of that traffic, while they have expended both upon the railway itself. The rolling stock is now in a transition state, and the various newly introduced improvements, imperfect as they are in many ways, point to an advancement toward the standard which has existed here for many years, and which has made the American so impatient at and contemptuous of railway traveling in England. The American car has certainly attained to a high standard, higher than that of the track which carries it, but there are many improvements yet to be made, both in the ordinary and special cars. One objection to the former has already been referred to, and in the latter there is too great a tendency toward barbaric splendor, as unnecessary and expensive as it is inartistic. In lighting and heating, the special cars and a considerable proportion of the ordinary cars are very well equipped; but the efficiency can be still further improved, and the systems must be more generally adopted, while the problem of ventilation, particularly of sleeping cars, yet remains to be solved. The proportion of dead load to paying load is far too great in many of our special cars. In freight rolling stock also America is ahead of England; but already the American car, with its advantages of light weight, great carrying capacity and flexible wheel base is being introduced there, and there can be no doubt of its advantages for bulk freight, such as ore, coal, salt, manufactured articles in large shipments, etc. It may be said, however, that the advocates of the present English system of small cars have some good arguments in favor of that system for small shipments and short hauls, in which there is considerable traffic. The management of this traffic could apparently be made more efficient, and the small cars themselves are capable of great improvement.

Now let us briefly compare the train appliances. In England there are no automatic couplers, and while some of the freight cars can be coupled and uncoupled by a man standing outside of the track, in general the man has to get between the cars and hook up the coupling chain, the same as with passenger cars. The space between the cars, owing to the spring buffers or fixed bumpers at each corner, affords some safety to the men engaged in the work, but large numbers are killed and injured every year by being caught between the buffers or run over while dodging under them. Passenger cars, and sometimes freight cars, have the couplings drawn tight by a screw, but most of the freight trains have slack chain couplings. The use of continuous and automatic brakes on passenger trains is now compulsory, but there is a lack of uniformity, various systems being used, of greater or less efficiency. The Westinghouse air brake is used on some roads, notably in Scotland, but the vacuum brake is more common. No continuous brakes are used on ordinary freight trains, and the hand brakes which are fitted to many of the freight cars can only be applied by a man standing on the ground, so that they are only of use in switching. The trains are therefore controlled by the brakes on the engine and caboose. These trains are run at very high speeds, this being made possible by the universal use of the absolute block system, and of special tracks for freight traffic. In America the Westinghouse automatic brake and the automatic coupler are almost universally used on passenger trains, and their use on freight trains is steadily increasing; but the old-fashioned link-and-pin coupling, and the hand brakes, worked by a hand wheel at the top of each car, will be responsible for thousands more of deaths and injuries among the crews of freight trains before these safety appliances are in general use. As for the cars themselves, the latest innovation is the use of steel throughout, and various improvements in construction are being introduced from time to time.

In the matter of average speed it must be admitted that the ordinary express trains on English railways make better time than the same kind of trains in this country, and in this, as well as in keeping schedule time, great improvements can be made here. This, however, is a matter which will steadily improve as a sequence of other improvements. The heavy traffic between the principal eastern points and Chicago in connection with the Columbian Exposition of 1893, and the competition for this traffic between the several roads running through or connecting trains, will probably lead to a very considerable increase in speed and shortening of the time between these places, to provide for which the track will also require improvement in many cases. The question of rates is too wide to be considered here, but it may be well to point out the great disadvantages of the costly method now in operation in this country, which, with its rate wars and other evils of unlimited competition, absorbs a large amount of money which might otherwise be applied to general improvements. The Interstate Commerce Law, as administered by the Interstate Commerce Commission, seems to be the entering end of a wedge to split up this present costly, unsystematic and almost unrestricted method of establishing rates, and will very likely lead eventually to the development of a regular system of rates and fares under the control of a government board. Such control will be a good thing for the railways and their stockholders. In England the railway acts establish the maximum rates and fares, and a general revision of freight rates is now being carried out by the Board of Trade, a work which of course leads to much friction between the authorities, the railways and the traders.

Special attention is called to the fact that the English government, through the Board of Trade (or the Railway Department of that board), exercises control over the chartering, construction, equipment, operation and charges of the railways, and that the railways have to conform to the regulations established by that board, while newly built railways cannot be operated until they have been inspected and approved by the engineers of the board. Government ownership of railways is rarely in the interests of commerce or the public convenience, but the English government has no sort of interest in or ownership of the railways, the control it exercises being in the interests of the general community. In this country there is already a movement in favor of a somewhat similar system. This movement began with the regulation of rates, and is already extending toward safety appliances, as evidenced by recommendations and individual state laws in regard to car couplers, freight-train brakes, steam heating, etc. It is to be hoped it will lead to the establishment of a permanent non-political board of railway control as a department of the general government, with practically the same scope as the English Board of Trade, but on somewhat improved lines. Its work should include the supervision of the granting of charters, but without the cumbrous and costly system in force in England; the organization of rules and regulations in connection with construction, equipment and operation; the regulation of rates and fares; the inspection of railways, periodically or upon complaint; the investigation reporting upon and keeping records of railway accidents, while it should have power to order improvements or alterations after such investigations (a power not possessed by the English Board of Trade), and the keeping of statistics. The department would be a higher authority, above the state boards of commissioners.

Taking into consideration the circumstances under which American railways have been built and developed, the intricacies of their financial conditions, the extent of country served and the amount of traffic, as well as the number of accidents, the American railway system compares well with that of England. The latter have cost very much more money, but without proportionate results in point of traffic facilities or convenience. Granting the very evident defects in management and financial affairs, and that there is too great a tendency to get traffic at any cost, without due regard to general improvement, it may be fairly said that the American railway has been built to meet existing requirements, and has been developed and improved as its traffic has grown and its property increased. This, properly carried out is the right principle for economical (not cheap) construction and operation of railways, in the interests of the companies, the traders and the community at large. English railways are open to many improvements, but they are being made rather slowly, and as necessity compels. American railways are open to still greater improvements, but they are being made rapidly, continuously and with spirit.

Finally, it may be said, as the results of investigation of both systems, that both America and England have features in their railways and railway practice in which each is superior to the other, and that, while neither has attained to anything like general perfection, they are both developing and improving in many ways. The ultimate result will evidently combine the best features of both systems, since each country is gradually adopting many of these features of the other as they come to be more generally known and understood, for it must be said that at present the railway men of both countries are not, as a body, well informed as to the progress of railway improvement and development in the country across the water.

CORRESPONDENCE.

Accident at a Railway Crossing.

TEMPLETON, Wis., June 21, 1891.

TO THE EDITOR OF ENGINEERING NEWS:

SIR: An accident happened yesterday morning at the Duplainville railway crossing which calls in question the value of the interlocking system as constructed at that point. It would appear that the operator in the tower had fallen asleep. In the mean time a freight train upon the Chicago, Milwaukee & St. Paul R. R. approached the crossing from the west; the engineer saw the signals were at safety and proceeded on his way. At the same time a train approached the crossing on the Wisconsin Central R. R. from the south; the whistle of this train woke the operator and he threw the switch to safety for the Wisconsin Central train; the Chicago, Milwaukee & St. Paul train was then but a few feet from the crossing, and of course was derailed, the locomotive running on the road bed until it ran over the crossing, when it rolled into the ditch, bottom side up. This shows that the derailing switches are much too near the crossing, and had the Wisconsin Central train been on the crossing at the time it would also have been wrecked by the locomotive of the St. Paul train.

This is the second accident at that point caused by the error of the signalman in about a year; the first accident was to a passenger train, but fortunately the train was moving very slow and no damage was done. In this case about 20 cars were badly wrecked and the engineer and fireman injured. W. P.

Notes on English Railways; The Southeastern Railway.

Southeastern Railway,
LONDON, June 19, 1891.

TO THE EDITOR OF ENGINEERING NEWS:

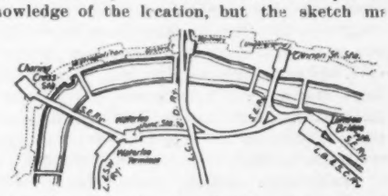
SIR: I think the opening observations in the article on the Southeastern Ry. are objectionable. With regard to the rolling stock of the company we have for some years past spent very large sums, not only in the purchase of new and improved stock, but also in the improvement of the general rolling plant, and I am quite sure we compare most favorably with other lines in this respect. As to the charge of unpunctuality I may inform you that recent returns sent to the Board of Trade show that the times of our trains are quite equal to those of the companies throughout England generally, and in some respects we show a better result than our neighbors on the south side of the Thames, notwithstanding the exceptional difficulties that we have to contend with in working the traffic between London Bridge, Cannon Street and Charing Cross. It is between these points that the delays chiefly arise. The cause is the exceptionally crowded state of the lines, and the company has been and is (as perhaps you are aware) spending very large sums of money in widening the Cannon Street and Charing Cross bridges and also widening the lines in the neighborhood of London Bridge with the view to prevent complaints arising. With respect to the conduct of the staff of the line I am very much surprised that you should make such remarks. Our staff has got a high reputation for courtesy and attention to passengers. I may say that I do not receive a dozen complaints a year, against the staff, of incivility and inattention to the public.

MYLES FENTON,
General Manager.

[Sir MYLES FENTON is well known as an able railway manager, and in justice to him and his road we will answer in detail his objections to the article in question (ENGINEERING NEWS, May 23, 1891). There is a prejudice in the public mind against this road, which may be due largely to former conditions, and certainly very great improvements have been made within the last few years. As to the rolling stock, particulars were given of the newer styles of cars, some of which are undoubtedly equal to those of other roads, as may be seen by some of the articles on other English railways, but the old cars of some of the London local trains on this line are very poor equipment for an important railway, and are probably unique, although the London, Chatham & Dover Ry. has also a number of small, bare and uncomfortable cars on its local trains. The Government return referred to in the above letter gives the percentages of trains arriving at London on time or late during May, 1890, from which we have condensed the following table, and, if the percentages for that month are a fair average, the performance is better than the road is generally credited with. It has been remarked in some of the preceding articles that the punctuality of English trains was not found to be so regular as had been expected.

	On time and 3 mins. late.	3 to 10 mins. late.	10 to 20 mins. late.	Over 20 mins. late.	Total No. of trains.
London Bridge..	88.06	9.96	1.400	.520	6,458
Cannon Street..	78.30	20.49	.835	.375	1,318
Charing Cross..	71.38	20.20	3.400	2.020	5,422

As to the behavior of the employees, that is a matter of personal experience and opinion. It was mainly an indifference or passive incivility, rather than the active incivility daily experienced on some of the New York elevated railways. The fact that so few complaints are received cannot be considered as a proof on this point, as railway travelers are much more likely to suffer in silence or content themselves with a growl at the railway than to make formal complaints, and probably very few complaints of the conduct of the elevated railway employees above mentioned are made to the general manager. The difficulty of operating the heavy traffic at the London terminals of the Southeastern Ry. can hardly be realized without a personal knowledge of the location, but the sketch map



Sketch Map of the London Terminals of the Southeastern Ry., England.

below, together with the preceding table and article in our issue of May 23, will give a general idea of the conditions. The Waterloo terminus of the London & Southwestern Ry. has a spur track to the Southeastern Ry., but there are no regular through trains. The London, Brighton & South Coast Ry. has a terminal station at London Bridge. The following note is an abstract from an article in an English paper in November, 1888:

There is no piece of traffic which requires so much care and is attended with so many difficulties as the working of that part of the Southeastern system which lies between London Bridge and Cannon Street and Charing Cross. Trains from London Bridge to Charing Cross cannot get in without crossing the path of outgoing trains from Cannon Street, so that there is a constant crossing and recrossing. Every down train from Charing Cross crosses two up lines to get onto the down line. The space in the stations is so limited that empty as well as loaded trains must be immediately dispatched, and in consequence of the shortness of the line at the south side of Cannon Street Bridge, an empty train from Charing Cross, which is being sent down to Rotherhithe Road, where they are stocked, may completely block Cannon Street station. It often happens that there are trains standing at every signal for some distance down the road, a delay with one necessarily affecting all the others, both up and down. Under these difficult conditions no fewer then 350 loaded trains are daily taken into and sent out of Cannon Street and Charing Cross stations. The company has acquired land for the purpose of widening the viaduct between London Bridge and Charing Cross, which at present carries three lines, and of extending and widening the stations at London Bridge and Charing Cross. The doubling of the bridge at Cannon Street will give 10 instead of 5 lines into that station, and the Charing Cross Bridge now furnishes 6 instead of 3 lines.

Since 1888 many of these improvements and extensions have been completed; but the traffic has continued to increase and is still very difficult to handle promptly and satisfactorily.—ED. ENG. NEWS.]

An Advance in Mine Ventilation Necessary.

In a late issue of the *Coal Trade Journal*, Mr. P. P. QUACKENBOSS, a chemist of long experience, suggests a problem to mining engineers and to those interested in mine ventilation that is novel, to us at least, and has a most important bearing upon the safe and more efficient working of mines. We publish the letter in full, and elsewhere make some comment upon it:

In view of the rapid development of the science of electricity as applied to the art of mining as it is carried on at present, it becomes necessary to provide for a larger factor of safety in the methods of the future than we seem to possess now, and as the obsolete methods and ideas of the past are brushed aside, care must be taken that the lessons gained by experience shall have due weight with the engineers intrusted with making necessary changes. Yet, also, that "conservative ideas" shall not be allowed to become a stumbling block.

My attention was attracted some time since by a statement of a prominent engineer in charge of one of our foremost electrical companies "that he had serious doubts of the advantage to be gained by engaging in the mine business, as the danger of explosion from an electric wire in a *gassy mine* was an omnipresent feature that could not be controlled with our present facilities." I repeated this remark to another equally prominent engineer, who corroborated the remark and stated that he "was at that time giving the matter his personal attention, as it was the keynote to success to be able to remove the danger." My attention being thus directed into this channel, my knowlege as chemist of the constituency of gases naturally came to my aid and enabled me to understand certain unexplained actions on their part which seem to require elucidation. Without taking up unnecessary space in describing mining methods of to-day, I wish to premise that with all the precautions that engineering science has thrown around the use of the equipment of a mine of to-day, it is only by a constant vigilance on the part of those engaged in such pursuits that destruction is avoided, as the danger seems to be an ever-present and ever-increasing one. Yet owing to the unfortunate policy of supplanting intelligent labor with the cheaper immigrant from abroad, all precautions seem to be wasted and only to give a color of right to the declamatory efforts of the demagogues of those regions. It thus becomes necessary that some concentrated action must be taken in the near future, by the owners and operators, to preserve their property, if they find it endangered by the carelessness or recklessness of the miners, who became indifferent to danger through constant acquaintance with it.

The first and most important subject is fire-damp (CH_4), owing to instant effects, and the second is choke-damp (CO_2), which, though slower, is equally deleterious, and these are not confined to one spot, but by falls of roof in gangway or drift, or by miners' blasts in the rooms, are liable to appear at any time and in all parts of the mines; and not only the immense first cost of a plant, but the continuing and increasing cost of maintenance, are all at the mercy of any one poor fool who willfully takes his life in his hand and a naked lamp in his cap. Air splits and brattices and all the known methods of controlling these gases fail at the one crucial moment, though, perhaps, a more frequent attention to their duties by the highly salaried officers might be of advantage. If, however, a more determined effort shall be made by those in authority to comprehend the nature of these gases and to control their effects, we may improve the condition of our property, add to the safety of our employees, and largely increase our profits, and for these reasons I present a few facts for the consideration of our engineers that may be of some assistance.

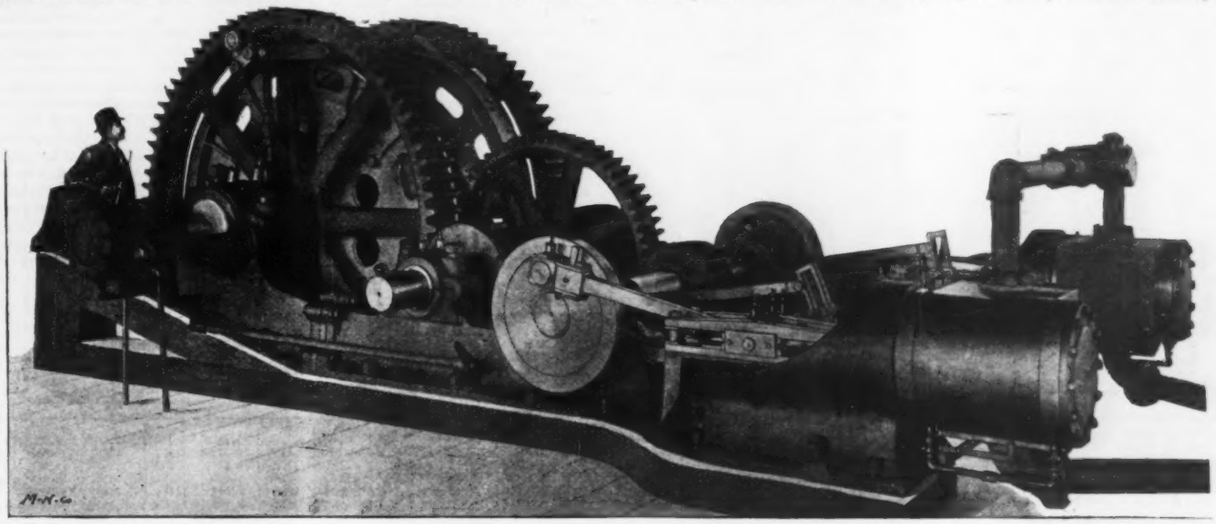
My first thought was that forcing hundreds of thousands of cubic feet of air into an air shaft to eliminate a few hundreds of feet of gas was a waste of power. Then, again, it was being constantly polluted by mephitic gases during its journey through a mine from the natural exudation of "blowers" and "blasting." Then carburetted hydrogen as it makes its first appearance in a mine is a *dry* gas and is expansive and inflammable, but if it finds an excess of hydrogen present it becomes a *saturated* gas and explosive. Thus density and humidity add hydrogen in a finely subdivided state, and it only needs a little agitation of the air and gas to prepare a big or little pyrotechnic display. The experiments shown by Thos. SHAW, M. E., with his celebrated *Inspector's Mine Gas Testing Machine* have been of the greatest use to the miners and operators of to-day in demonstrating subdivisions of gases, and in the hands of state inspectors will prove invaluable in the future. But of what use is it to know of dangers if they are not avoided in consequence of that knowledge? Therefore, if knowing the nature of CH_4 we see another element of danger about to be added to it, we need not wait for the damage to occur. The ordinary condition of a mine did not seem to present to my mind the excess of hydrogen spoken of above, so I sought for it in the air forced into the mine by the fan at the mouth; then I saw at once that barometric change would produce the result if other conditions were right, and so taking a list of mine explosions to Sergeant DUNN, the signal service officer, at New York, and explaining my theory, we took the record of temperature issued by the War Department, and selecting four cases, as follows, were surprised at the record.

Jan. 23, 1889, at Wilkes-Barre, explosion of mine gas. At that time the report shows a high pressure just passing off and a low pressure just approaching from the W. S. W.; barometer 30.10. April 15, 1889, at Wilkes-Barre explosion and *precisely* the same conditions. Jan. 18, 1890, at Avondale, exactly the same conditions and result. June, 1890, the Hill Farm explosion at Dunbar, exactly the same conditions and result. We then started again with a list commencing with an explosion at Rich Hill, Mo., March 23, 1888, and again the high pressure was receding and low pressure approaching; barometer 30.10 to 30.20. In all the cases from then down to Jan. 1, 1891, the conditions are identical, and in each and every case the humidity was increasing so as to be marked plus. There we have the necessary conditions to create an explosion added to by a fan-blower forcing a dense humid air down a mine like a gunner ramming home a charge in a gun. There is the death knell to the present system of ventilation, and the engineers will be forced to reverse their fans, and exhaust from their mines instead of forcing air in. Another point I wish to suggest is that as gas is lighter than ordinary air, it rises to the roof and pipes of proper size and material would draw out the gas first. If proper openings and short pieces were put at suitable distances

with the necessary slides for closing those not in active use, the mine boss could start into a mine, and by opening and closing these vents would be able to eliminate all the gases collected in the galleries, air shafts or drifts before the men came in, and if falls of roof occurred during the night, damaging the pipe, it would not be very expensive to replace it on my plan. If this shall be carried out I am led to believe that we can introduce the electric current into our mines with almost perfect safety.

Hoisting Engines and Dipper Dredge for Montreal Harbor Works.

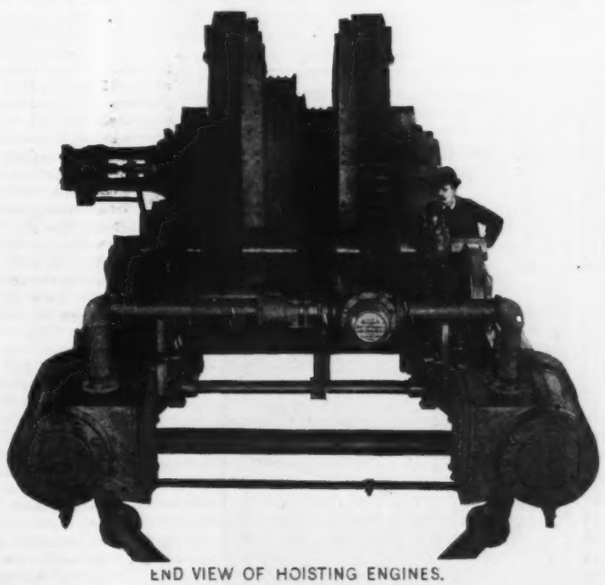
A powerful dredge has recently been built for the harbor of Montreal, to work in very hard material, and capable of use in 40 ft. of water Through the courtesy of the Bucyrus Steam Shovel and Dredge Co., Bucyrus, O., who furnished the main portion of the machinery, we illustrate the main hoisting engines of this dredge, which possess some novel features. The machinery was built to the general specifications of Mr. John Kennedy, the Chief Engineer of Montreal Harbor, and designed in detail by Mr. A. W. Robinson, the Mechanical Engineer of the Bucyrus Steam Shovel and Dredge Co.



HOISTING ENGINES FOR DIPPER DREDGE.

Bucyrus Steam Shovel & Dredge Co., Builders. John Kennedy and A. W. Robinson, Engineers.

The engines are designed to exert a direct pull of 120,000 lbs. upon a steel wire rope 2½ ins. diameter The drum is of differential diameter, so that the strongest pull at low speed is exerted while the bucket is digging, and the speed of the hoisting increased at once for lifting. The cylinders are 16 ins. diameter by 18 ins. stroke, fitted with link motion and Allen-Richardson balanced valves. The main drum is loose upon the shaft, and is driven by double friction clutches. The conditions to be fulfilled by these frictions were somewhat difficult, as shown by the following extract from Mr. Kennedy's specifications:



END VIEW OF HOISTING ENGINES.

"The drum to be driven by a friction clutch at each end, which must be of some kind that has been proved to be thoroughly satisfactory for working dredges. They must be capable of being gripped fast under the full power of the engines, or of being slipped smoothly at any desired rate; or, in other words, they must be such that, with the engines running ahead, the bucket can be lowered, held, raised and otherwise satisfactorily worked wholly by means of the frictions; and while being so worked, the surfaces are not to grind or heat injuriously. The power for compressing the frictions is to be furnished by a steam cylinder. The cylinder valve is to be worked by small levers placed on the engineer's platform, and the whole to be so arranged that the degree of compression shall be as completely under the control of the engineer as with ordinary hand compressors. Everything about the frictions liable to wear is to be made adjustable for such wear, and to be easily renewable separately."

These requirements called for some special and delicate treatment, it being necessary that the adjustment be very sensitive and yet capable of dealing with heavy strains. The interval between fast and loose must also be nicely graduated, so that the gripping and releasing will not take place suddenly. Outside band frictions were adopted, the bands being lined with hard maple blocks. The bands are set up by a peculiar toggle movement, so arranged that as the resistance increases by tightening the band, the power remains practically uniform. The toggles are worked radially from the shaft, and an ingenious device dispenses with the usual end motion required, or sliding collars, thus enabling the main bearings to be brought close up against the wheels, and reducing the span between the bearings, and consequently the bending moment upon the shaft.

The shaft is of hammered steel, 12¼ ins. diam., and with drum and gears upon it weighs 31,000 lbs. The steam cylinder for operating the frictions is shown, attached directly in line with the shaft. It is fitted with a compensated valve, whereby the motion of its piston (and consequently the degree of application of the friction) is limited and made to coincide with the lever for operating it. The handle on the engineer's platform for controlling the frictions is a light, polished affair about 16 ins. long and moved almost without effort, and the whole of the immense engine is made instantly responsive to the will of the operator.

Besides the engines illustrated there are two pairs of auxiliary engines and powerful machinery for working the enormous spud anchors with which the dredge is fitted, and which were likewise furnished by the Bucyrus Steam Shovel and Dredge Co.

Steam-Engine Efficiencies: The Ideal Engine Compared with the Real Engine.*

The writer has been much interested of late in making a number of comparisons of the efficiencies computed for the ideal thermodynamic case of the steam engine, as by the exact methods of RANKINE or of CLAUSIUS, with those obtained when the conditions which distinguish the actual from the hypothetical engine are introduced. The ideal engine, as the term is here employed, is that which is treated of in all purely thermodynamic studies of the engine as free from those wastes of heat and of power which distinguish the operation of the real engine, as a consequence of the existence of friction and the action of conduction and radiation in the dispersing, in useless ways, of heat which should be applied with best effect in thermodynamic transformations. The ideal engine is one which is assumed to have a non-conducting cylinder and frictionless rubbing parts. Its wastes are simply those which are unavoidable and characteristic in all thermodynamic operations. The real engine, on the other hand, is not only subject to those wastes by unavoidable rejection of heat at the inferior limit of adiabatic expansion, but loses heat by conduction and radiation to surrounding objects in considerable amount, and by internal transfers without transformation in very large amount, often; and also wastes a serious percentage of the power actually obtained by transformation out of heat energy in the work of overcoming the friction of its rubbing parts, and of forcibly rejecting the working fluid against an artificially produced back pressure.

In the time of RANKINE and CLAUSIUS only the thermodynamic or ideal case was considered in the theory of the engine, the introduction of these mechanical and physical changes and wastes of energy only having been introduced to form a complete theory of the actual case since their time. The theory of the real engine is thus a mixed theory, involving thermodynamics, physics of heat and the dynamics of friction.

The following interesting computations, made for the writer by Mr. KUEHMSTED, illustrate the sometimes great differences between the purely thermodynamic efficiency of the engine and the actual efficiencies as modified by

* A paper by Prof. R. H. THURSTON, read at the Providence meeting of the American Society of Mechanical Engineers.

hese later extensions of the theory to adapt it to actual practice. The actual figures presented are not so much of importance, since they may or may not accord with any given cases in practice, as the conditions here assumed may approximate more or less closely to those observed in the actual case. The main interest attaches to their illustration of the general effect of such modification in the development of the modern theory of the engine, and the exhibition of the method of variation of the efficiency and economy of the engine, with changing conditions as to extent of expansion of the steam and the power of engine.

The cases to be investigated in this provisional and approximate manner are those which may possibly represent a later practice than is yet reached, the steam pressure being what is now regarded as above the usually practicable limit for our time. They include the study of the non-condensing engine worked at a pressure of 250 lbs. per sq. in. above a vacuum, with ratios of expansion ranging from 5 to 20, the back pressure being assumed at 16 lbs. above a vacuum, and the temperature of feed water at 203° Fahr., a comparison being made between the ideal thermodynamic case and that of the real engine, subject to a moderate amount of waste. They also include the case of the condensing engine working under similar initial pressures and at ratios of expansion ranging from 10 to 50, and with feed water at 101° Fahr., similarly compared with a case representative of practical working conditions. The back pressure is assumed to be 5 lbs. above a vacuum.

In making these comparisons, the methods and formulas of RANKINE are adopted as most convenient and simple, and as giving approximations which, so far as inaccurate, are probably on the right side. The cases thus computed would in no way differ from those illustrated in the examples given in the works of that author, except as differences of data give difference of numerical results.* An interesting collection of data and results may be found in RANKINE'S works, in all cases illustrating the ideal case. In the cases here assumed, the jacketed engine is studied, and the conditions of action of the jacket are taken as assumed by RANKINE, *i. e.*, that the jacket is so effective as to keep the initially dry steam in the dry and saturated state quite up to the end of the expansion period. It is further assumed that the wastes of heat by conduction and radiation, internally and externally, mainly in the exhaust period, may be represented approximately by an expression of the form deduced by the writer from earlier observation and especially from the Sandy Hook experiments, as a factor, constant for any given engine, multiplied by the square root of the ratio of expansion.† This constant is here taken as 0.15 for a simple jacketed engine and as 0.075 for the jacketed compound engine, which figures are sufficiently accurate for the purpose here in view. It is only necessary to assume that the engines here to be considered are of substantially the size and construction of those the trials of which give similar figures for wastes. The Sandy Hook engine may stand for the simple engine, for example. The real case is taken to be that of a compound jacketed engine; for the ideal case there is of course no distinction between the simple and compound.

Taking up the first step in the series of problems we determine the thermodynamic efficiency of the steam, dry and saturated, under the prescribed conditions of the ideal case. In assuming a relation between the weights of steam and of fuel demanded, it is considered that the efficiency of the boiler should be such as to give an evaporation of at least 9 lbs. from 101° Fahr. and of 10 lbs.

* COMPOUND STEAM-ENGINE, JACKETED.
NON-CONDENSING.

	IDEAL CASE.																		REAL CASE.			
r	r_1	$r_2 = r\,r_1$.	p_2	p_3	$r_2(p_2 - p_3)$.	U_1	U_2	$U_1 - U_2$.	$U' = r_1 - r_2 + r_2(p_2 - p_3)$.	H_2	(Feed = 203°) h_4.	$h = U_1 - U + H_2 - h_4$.	$H_1 - h_4$.	Q Heat supplied by Jacket pr. lbs. steam. $h - (H_1 - h_4)$.	Effic. $= \frac{U_1}{h}$.	S Lbs. H_2O worked in Cyl. pr. I. H. P. pr. hr. 1,930,000 / U_1	m (10) Coal to Evap. S / 10 and 9	n Coal to supply heat supplied Jacket. $Q\,m$ / $H_1 - h_4$	Total fuel. $m + n$	$1 + 0.075\sqrt{r}$.	Efficiency.	Water per I. H. P. pr. hr.	Coal per I. H. P. pr. hr.
5	1.84	9.2	6.491	2.304	38.548	424.280	312.633	107.647	146.195	893.854	132.330	875.141	797.251	77.890	.1671	13.54	1.354	.1354	1.489	1.168	.1430	15.815	1.739
8	"	14.72	3.931	"	23.949	"	283.189	137.091	161.049	892.916	"	897.647	"	100.396	.1794	12.29	1.229	.1593	1.389	1.212	.1480	14.895	1.683
10	"	18.40	3.102	"	14.683	"	269.523	150.757	165.443	889.950	"	913.357	"	111.106	.1821	11.93	1.195	.1674	1.363	1.237	.1472	14.795	1.686
15	"	27.60	1.987	"	− 8.749	"	245.228	175.052	166.303	884.604	"	927.296	"	130.045	.1791	11.91	1.191	.1903	1.382	1.299	.1392	15.364	1.783
20	"	36.80	1.483	"	− 30.213	"	228.319	191.951	161.748	881.093	"	940.694	"	143.443	.1720	12 24	1.224	.2303	1.441	1.335	.1290	16.310	1.928
	CONDENSING.																						
5	18.4	9.20	64.94	720	53.121	420.280	312.633	107.647	160.768	899.554	55.612	951.889	873.999	77 890	.1689	12.315	1.368	.1:2	1.490	1.168	14.46	14.384	1.740
10.	"	18 40	3.102	"	43.829	"	269.523	150.757	194.586	889.960	"	985.105	"	111.1 6	.1975	10.170	1.130	.142	1 272	1.257	.1597	12.580	1.573
20.	"	36.8	1.483	"	28.078	"	228.319	191.961	220.039	881.193	"	1,017,442	"	143,443	.2163	8.995	.969	.172	1.171	1.325	.1620	12.008	1.563
30.	"	55.2	961.	"	13.303	"	204.958	215.322	222.625	876.434	"	1,096,144	"	162,145	.2207	8.660	.562	.1732	1.135	1.411	.1564	12.360	1.601
40.	"	73.6	709.9	"	−743	"	189 023	231,257	230.514	873.373	"	1,049.018	"	175,019	.2197	8.59°	.954	.189	1.143	1.474	.1491	12.662	1 685
50.	"	92 0	559.9	"	−14.729	"	176,086	243,625	238.896	871,067	"	1.059,080	"	185,081	.2161	8.630	.961	.208	1.169	1.520	.1410	13.235	1.789

p_1 = 36,000 lbs. per sq. ft. = 250 lbs. per sq. in. [absolute initial pressure of steam.]

* For the benefit of readers whose memory of RANKINE'S formulas may be a little rusty, we give the values of the principal quantities found in the table as follows:

r = ratio of expansion.
r_1 = volume of 1 lb. of steam when admitted.
r_2 = " " after expansion.
p_2 = absolute pressure of steam after expansion,
p_3 = " " during compression (mean),
U_1 = energy of 1 lb. of steam at initial pressure.
U_2 = energy of 1 lb. of steam at exhaust.
U' = energy exerted on piston by 1 lb. of steam,
H_2 = total heat of evaporation,
H_1 = heat received per pound of steam,
h_4 = heat saved in consequence of feed being above temperature of melting ice.
h = whole expenditure of heat in foot-pounds per pound of steam.

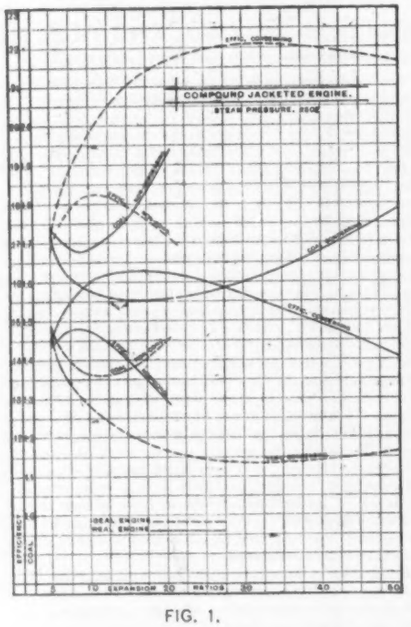


FIG. 1.

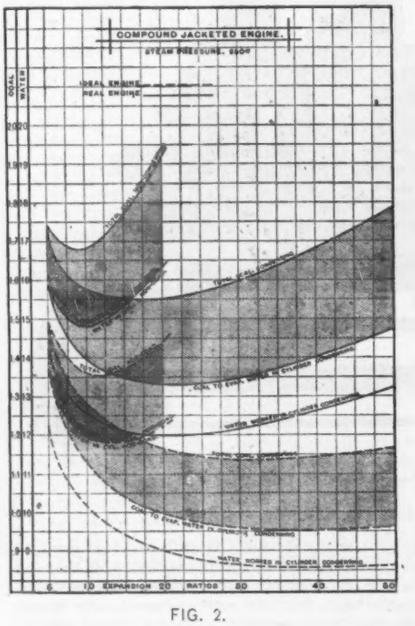


FIG. 2.

from 203° Fahr. per lb. of coal, which is equivalent to about 10.5 lbs. from and at 212° Fahr. under atmospheric pressure. It is assumed that the jacket water drains completely and automatically back to the boiler, as always should be the case; the neglect of this precaution often making a sensible reduction of the efficiency of the system. The results of these computations are given in tabular form in the annexed general table of figures, data and results being presented so fully that comment is hardly necessary. It will be seen that the efficiencies range from 16.7% to 18.2% in the case of the non-condensing and from 16.9% to 22% for the condensing engine, the maximum being found at a ratio of expansion in the first case of about 10 and in the second of about 30. Beyond these ratios the terminal pressure falls below the back pressure, and a waste follows instead of gain by further expansion.

These results are still better exhibited by the curves (Figs. 1 and 2) plotted from the numerical values; the ideal case in both series being represented by dotted lines, and the real engine giving the widely different curves in full lines. The great difference between the condensing and the non-condensing engine for the ideal case is well shown, not only as to consumption of fuel at a similar ratio of expansion, but also as affected by changing values of that ratio. The gain by expansion in the former case continues far beyond that at which the latter finds a limit; while the point of maximum effect is far more sharply defined with the non-condensing engine. Variation from the best ratio for the latter causes much more marked loss than with the condensing engine. The numerical values obtained are presumably those which we should obtain if we were to find a way of building engines with working cylinders having non-conducting inner surfaces, as sought to be secured by the various expedients adopted or proposed by SMEATON, EMERY, the writer and others. The points of maximum efficiency and those for minimum consumption of steam and of fuel are coincident in these cases, and also that for minimum supply of feed water. As will be seen presently, this last is not the case for jacketed engines in either the ideal or the real case, in consequence of the fact that a part of the working fluid circulates continuously between jacket and

*It is unnecessary to reproduce the equations. They may be found in RANKINE'S "Steam-Engine," pp. 375-411, and are so well known that it would be simply pedantic to introduce either these expressions or the details of the work here, to encumber our pages.

†HATON DE LA GOUPILLIERE coincides with SINIGAGLIA, who says that this function was first proposed by the present writer, and subsequently confirmed by direct experiment at Sandy Hook and elsewhere.—*Cours des Machines*, vol. II.

boiler and makes no demand upon the source of supply for replenishment. At each cycle it gives up its latent heat of evaporation, that measurable as sensible heat remaining constant throughout its period of action.

Taking up the real engine, as modified by the assumed conditions of operation, and the computed probable wastes, we find that we must add to the heat supply a portion measured by the assumed heat wastes, and which we here compute by multiplying the amount of the thermodynamic case by the factor $1 + 0.075 \sqrt{r}$, that for one of the two cylinders of the compound engine under the prescribed conditions.

The efficiencies now range from 13% to about 15% and from 14% to 16% in the two engines respectively, a reduction of very considerable amount; while the best results are now given at ratios of expansion of not far from 8 and 20 in the two cases, respectively. The water consumption has increased from 12 to 14.8 lbs. and from 8.5 to 12 lbs.; and the fuel account has risen from 1.36 to 1.68 and from 1.13 to 1.55 lbs. per horse power and per hour for non-condensing and for condensing engines. These changes are best seen on the curves, the lower sets being those for the real engine, and the differences being best exhibited by the shaded areas separating the pairs on the second plate.

It will be seen that the effect of this introduction of wastes in the ideal as in the real engine is to reduce greatly the best ratio of expansion—that giving maximum efficiency—and to make variation from that ratio of maximum efficiency more seriously productive of loss; while at the same time making the differences between the several cases less than in the ideal engine. The following are the values of the ratios for maximum efficiency and for minimum steam and water consumption for the cases taken:

COMPOUND JACKETED ENGINE.

$p_1 = 250$; $p_2 = 5$ and 16; r variable.

CASE.	NON-CONDENS'G.		CONDENSING.	
	Ideal.	Real.	Ideal.	Real.
r For maximum efficiency	11	8.5	32	17
" minimum fuel	11	8.5	32	17
" " water.	13	9.5	38	21
Water rate	12	14.75	8.5	12
Fuel rate	1.35	1.68	1.1	1 55

The last given figures have no other than speculative interest, as the only important question is at what ratio will the least heat be demanded from the fuel?

The better the conditions of construction and operation of the engine, and the less the difference between the two sets of cases, the nearer will the value of the ratio of maximum efficiency and minimum expenditure of steam and of fuel approach a common value—that for the ideal case. The wastes assumed in the above computation are probably capable of being reduced, by careful drying or moderate superheating of the steam, and by adopting high speed of engine, to one-half these proportions. The figures here computed have been actually approximated by some of our best constructors when using steam pressures one-half those here assumed. It ought to prove practicable, one would think, to bring down the water-consumption by the adoption of these high-pressures, and by further dividing the wastes by the use of three or four cylinders in series, and by properly supplying dry steam to the engine, to within 10% of the best figures here obtained for the ideal case. This is, however, pure speculation, and the main interest attaching to these results comes of their clear illustration of the method by which efficiency varies with variation of the quantities entering these computations.

In computing probable wastes by the real engine, either the methods here adopted as first proposed by the writer or that lately suggested by Prof. COTTERILL or that adopted by Prof. MARKS, may be used. Either, if the method of use and the constants employed are rightly taken by reference to experiment, will give substantially similar and probably satisfactory results. The method employed by Mr. BUEL and approved by Prof. SMITH, also, for the usual case, will serve conveniently and fairly well for applying corrections to the thermodynamic problem in the attempt to adapt it to the real case.*

The real measure of the useful power of an engine is not the indicated power, however, but the dynamometric power, as measured by the brake, or at the point at which the engine delivers its energy to the machinery of transmission. A well-built non-condensing engine should have an efficiency of machine at least as high as 92.5%, and engines have been constructed doing better than this. An equally well-built condensing engine should approximate 90% efficiency of machine, though 85 is a much more common figure. Taking these maximum values for the two machines respectively, the last table comes modified thus:

COMPOUND JACKETED ENGINE.

Data as in preceding table.

Case.	Non-Condensing.		Condensing.	
	Ideal	Real.	Ideal	Real.
r [expansion ratio] for maximum efficiency	11	8.5	32	17
Water per dynamometric HP.	13	16	8.5	13.5
Fuel " " "	1.5	1.8	1.2	1.7

It is apparently doubtful whether a vacuum will be found desirable, with its concomitant costs for the air-pump system, when we come to the utilization of these high pressures, unless we can at the same time find a way to reduce its wastes of power and the tax thus imposed upon the engine.

*For these quantities and equations see papers in earlier numbers of the *Transactions of the A. S. M. E.*, the late new edition of Prof. COTTERILL'S admirable treatise on the steam engine, the papers of Mr. R. H. BUEL in the *American Machinist*, and those of experimentalists referred to by these several writers, and especially as summarized by Prof. COTTERILL. The constants h re taken are obtained by assuming the single-cylinder to have the general proportions and speed of piston of the Sandy Hook engine, the gain by jacke ing to be about as found by EMERY and a number of other investigators, including the writer, and the loss in multiple-cylinder engines to be substantially that of one cylinder. Engineers familiar with a different practice may assume a co respondingly different set of constants.

Electric Lighting of City of London.

The reproach that has frequently been made that in the public electric lighting of its thoroughfares London is far behind many of the American cities, and also in the rear of Paris, Berlin, Vienna, Milan and other Continental cities, will soon be a thing of the past, says our London correspondent. The first thoroughfare to be lighted is Queen Victoria St., which is already studded with a number of arc lamps arranged on iron standards about 30 ft. high. These lamps were experimentally lighted on several evenings lately, and the permanent illumination is to commence immediately.

This is, however, not the first occasion that arc lamps have been used in the city. About 10 years ago experiments were made, but as the lighting was unsatisfactory it was discontinued. Since that time the City Commissioners of Sewers—the authority controlling the lighting, etc., of the city streets—has been considering the subject as to the general adoption of electrical illumination. It was, however, only in 1890 that contracts were entered into with the Brush Electrical Engineering Co., Ltd., for the electric lighting of the central and western portions of the city, and the Laing, Wharton & Down Construction Syndicate, Ltd., for the illumination of the eastern portion. At present the cost of lighting the city by gas amounts to £10,000 per annum, but with the electric light the cost will be increased to slightly more than £20,000. Though the expenses will be greater, there will be at least ten times the amount of light. The three divisions of the city contain about 1,000 gas lamps of about a total of 40,000 candle power. These will be replaced by 400 arc lamps of 2,000 candle power, and 1,000 incandescent lamps, the latter being for the illumination of the small streets, lanes and courts. At the end of 21 years the City Commissioners of Sewers may acquire, if desired, the whole of the generating plant, buildings, cables, lamps, etc., used in both the public and private lighting.

The first step toward the lighting was the laying on Feb. 3 last of the first stone of the main junction box by the Lord Mayor of London in the presence of many distinguished visitors. This junction box will be used for connecting the mains of the two contracting companies, so that in the event of an accident occurring at either of the generating stations, current will still be available from the other stations. Since then considerable activity has been displayed in the laying underground of the mains, some of which are laid in 4-in. iron pipes and others in troughs. The first generating station of the Laing, Wharton & Down Construction Syndicate is in course of erection on the north bank of the River Thames, between the Customs House and the Tower of London. The first station of the Brush Electrical Engineering Co. is now almost finished. It is situated on the Surrey or south side of the River Thames, along the wharves termed "Bankside." This is about half way between Southwark and Blackfriars bridges, over both of which the cables have been carried. The area of the site is very large and there is ample space for six stations of the size of the one now practically completed. The first instalment of the plant is already in position. It comprises two Babcock & Wilcox water tube boilers of 250 HP. each, and two 40-light Brush dynamos which are driven by ropes from Raworth engines. Two Mordey alternators are about to be erected, together with the necessary boilers and engines, these being for private lighting. The total capacity of the station will be sixteen 40 arc-light machines and alternators, yielding a total output of 3,000,000 watts, or say just over 4,000 HP. The boilers will all be of the Babcock & Wilcox type, which is now so frequently adopted in London central stations, while the engines will be of the Raworth make.

The concessions of both companies are to be transferred to the already constituted City of London Electric Light Co., and to another company yet to be formed. It is expected that the demand for light by private consumers—which is a monopoly of the companies—will be very considerable, and that the commercial prospects of the undertakings are very favorable.

CONSTRUCTION NEWS.

RAILWAYS.

EAST OF CHICAGO.—Existing Roads.

Cincinnati, Portsmouth & Virginia.—This company, which was chartered recently to take the place of the Ohio & Northwestern Ry. Co., has elected the following officers: President, Samuel Hunt; Secretary, Thos. D. Rhodes; Treasurer, Thos. Hunt; General Counsel, H. C. Hollister.

Temiscouata.—About one-third of the grading has been finished on the 12-mile extension of the St. Francis branch of this New Brunswick railway.

Philadelphia & Seashore.—The extension of this railway from near Tuckahoe to Sea Isle City, N. J., 10 miles, has been completed.

Western New York & Pennsylvania.—The change of line from Ross' Crossing to Swain's, Pa., 5 miles, is nearly completed.

Parry Sound Colonization.—About 10 miles of track have been laid on this line from Parry Sound, Ont., to Elmsdale, Ont., 48 miles. It is expected to have 30 miles of the line finished this season.

Projects and Surveys.

New Jersey Extension.—A company by this name will probably be chartered in New York to build a railway from Newark, N. J., to the Poughkeepsie Bridge. The Central R. R. Co. of New Jersey is rumored to be backing the enterprise.

Skowhegan & Norridgewock.—The Maine Central R. R. Co. has offered to guarantee the payment of $75,000 of 4% bonds to provide for the construction of this 5½ mile Maine railway.

Kennebec & Franklin.—John F. Hill, of Augusta, Me., President, writes that this railway is projected to run from Farmington, Me., via Mt. Vernon, Vienna, Fayette, Wayne, Manchester and Augusta, to Gardiner, Me., a distance of 40 miles. No surveys have yet been made. A. M. Spear, Gardiner, Me., Treasurer.

Plymouth & Middleborough.—The following are the conditions on which this Massachusetts railway is to be constructed: The Old Colony R. R. Co. is to furnish rails, sleepers and ties for 8 miles of the road, taking a note from the projectors of the enterprise as a nominal security. Then the Plymouth & Middleborough directors will take the money subscribed by the towns of Plymouth and Middleborough and by individuals, amounting in all to about $80,000, and proceed to build 8 miles of road, which it is proposed to bond. With the funds thus secured the remaining 8 miles of road are to be constructed. When the line is completed the Old Colony will operate it for 70% of the receipts.

Westerly & Jewett City.—H. E. Chamberlin, of Westerly, R. I., writes us that the surveys have been completed for this railway from Westerly, R. I., to Jewett City, Conn., 25 miles. The road will run through the towns of Ashaway, R. I., Volunton, Conn., and Griswold, Conn. The route is through a rough section of the country; maximum grade, 52 ft. per mile. There will be one bridge 100 ft. long. About $45,000 of stock has been subscribed in aid of the road. Thos. F. Chappelle, of Rutland, Vt., is Chief Engineer.

SOUTHERN.—Existing Roads.

Charleston, Sumter & Northern.—It is stated that only about 4 miles of track remain to be laid to complete this line from Sumter to Bennettsville, S. C. It is expected to have the line in operation by July 1.

South Bound.—At the annual meeting of the stockholders of this company the following officers were elected: President, H. M. Comer; Vice-President, B. A. Denmark; Treasurer, Herman Myers; Secretary, M. Hamilton; Chief Engineer, G. D. Wadley.

Charleston, Cincinnati & Chicago.—It is stated that arrangements are about completed whereby the uncompleted portions of this railway will be finished. The engineers employed to examine the line state that by the expenditure of about $500,000 the road can be so far completed as to enable it to earn the interest on its bonds. It is proposed to commence work at once and to have a large portion of the line completed this season.

Archer & Dunnellon.—About 350 men are reported on the railway from Archer to Dunnellon, Fla., and it is expected to have the line finished by Aug. 15. The Florida Central & Peninsular R. R. Co. will operate the road when it is completed.

Branchville & Bowman.—This road is now open for passenger business from Branchville toward Bowman, S. C., 9½ miles. Work is in progress on the remaining 2 miles to Bowman.

Middlesborough Belt.—The construction of the new Stony Fork branch of this railway is nearly finished.

Macon & Atlantic.—It is stated that work has been resumed on this Georgia railway by the contractors, J. S McTighe & Co., of Memphis, Tenn. The road is projected to run from Macon, Ga., to Calleton, on Port Royal Sound. About 100 miles are nearly graded and a small amount of track has been laid. It is expected that the line can be finished this season.

Georgia, Carolina & Northern.—Only 15 miles of track remain to be laid to complete this road to Athens, Ga. The bridge over the Broad River is nearly ready for the trains.

Projects and Surveys.

Charleston, Glendennin & Southern.—At a recent meeting of the directors the following officers were elected: President, F. W. Abney; Secretary, John B. Floyd, and Treasuer, J. D. Bain. About $50,000 of stock have already been subscribed.

Newton & Helvetia.—Chartered in West Virginia to build a railway from Buckhannon to the Left Hand Fork of the Buckhannon River. J. E. Craddock, of Buckhannon, W. Va., is one of the incorporators.

Chicago, Gulf & Mobile Point.—Chartered in Alabama to build a railway from Mobile, Ala., to Mobile Point, Ala.

Chesterfield & Kershaw.—This South Carolina railway has completed its organization by the election of J. W. McRay, of Cheraw, S. C., President, and a Board of Directors.

Gainesville, Rocky Point & Micanopy.—It is stated that the contract for building 2½ miles of this railway from Gainesville to Micanopy, Fla., has been let to H. A. Callison. Work will begin at the Micanopy end in a short time.

Chesterfield & Lancaster.—This South Carolina railway company has elected W. A. Evans President.

NORTHWEST.—Existing Roads.

Pawnee.—Joseph E. Burtle, Chief Engineer, is quoted as saying that work would begin on a 5-mile extension of this Illinois railway about July 10. It is also stated that an extension from Pawnee, Ill., to Taylorville, Ill., about 20 miles, will be built next spring.

Canadian Pacific.—Egan & Bros., the contractors, have commenced work on the extension from Melita, Man., to the Souris coal fields.

Duluth, Pierre & Black Hills.—Grading is making good progress in the section from Pierre to Aberdeen, S. Dak. About 15 miles have been graded from Pierre north, and from Aberdeen south nearly 40 miles are ready for the rails. The road is projected to run from Pierre to Oakes, N. Dak., 181½ miles. B. P. Tilden, Aberdeen, S. Dak., Chief Engineer.

Itasca Lumber Co.—This company has begun work on its proposed railway from Grand Rapids, Minn., north, 25 miles, into timber lands. The road will be operated in connection with the Duluth & Winnipeg R. R.

Projects and Surveys.

Duluth & Pueblo.—Dwight Hitchcock, President, is quoted as saying that the money necessary to build 100 miles of this road was secured, and that this much of the line would be completed this season. The road is projected to run from Sioux City, Ia., via Covington, Ponca, Neleigh, Ord, Wheeler and Culbertson, Neb., to Pueblo, Colo.

SOUTHWEST.—Existing Roads.

San Antonio & Aransas Pass.—Work has already begun upon the line from Lexington to Lott, Tex. It is expected to have it in operation by Sept. 1.

St. Louis, Grand Tower & Southern.—Work is to begin at once on this railway from East St. Louis to Grand Tower, Ill., 65 miles, for which the contracts were recently let. It is intended to have 26 miles in operation by Sept. 1. C. F. Stephens, St. Louis, Mo., Chief Engineer.

Kansas City & Independence Air Line.—Work has been begun upon this 5¼-mile railway at Kansas City, Mo. J. H. Heylman, Kansas City, Mo., Chief Engineer.

Projects and Surveys.

Anson & Abilene.—The citizens of Anson and Abilene, Tex., are making efforts to secure the construction of a railway between those two places. The two towns will give $100,000 in aid of any company that will build such a line.

Quindaro Circular.—Application has been made to the Secretary of State of Missouri for a charter to build a short suburban railway at Kansas City, Mo. A. A. Lovelace, Kansas City, Mo., is interested.

ROCKY MT. AND PACIFIC.—Existing Roads.

Burlington & Missouri River.—The Seattle *Post-Intelligencer* gives the following concerning the Western extension of this road:

Notwithstanding the frequent denials that the Burlington railroad will be extended to the Coast, it is being rapidly extended in this direction. The last official map of the road showed that the most western point reached by it was Buffalo, in northern Wyoming. Since that map was published the road has been constructed across the state line into Montana, and contracts have been let for an extension to Helena and Butte. The road will cross the Northern Pacific at Billings and run through Castle, where it will tap some coal mines, which are one of the objective points of it.

Great Northern.—J. A. B. Tompkins, Division Engineer, is quoted as follows, in speaking of the progress of work on the Pacific extension of this road:

There is now an abundance of labor, and construction is actively under way all along the line from the end of the track near Two Medicine, Mont., to a point north of Spokane Falls. The weather has been extremely favorable, as there has been much less rain throughout the Flathead country than elsewhere in Montana. Though there were large amounts of snow in the mountains, the prolonged cool weather caused this to melt very slowly and consequently there have been no damaging or delaying floods in the streams.

Between Bad Rock Cañon and Two Medicine many sections have been completed and are waiting for the rails, while work on the others is far advanced. Construction work in Bad Rock Cañon is progressing at a satisfactory rate. The 180-ft. tunnel there will be completed in 60 days. A large number of grading outfits are now en route from the completed work east of the Rockies to the Flathead Valley, where grading will commence at the Finchpaugh Cut, just east of Kalispell. The entire line is covered with graders from the west side of the Flathead Valley to the Kootenai Falls, where Burns & Chapman's contracts begin. The divisional yards in Kalispell will probably be 3,000 ft. in length. They will be unusually large to accommodate the heavy traffic of a transcontinental line, and also because at this point begins a change in the system of grades, requiring a complete rearrangement of all trains and change of class of motive power, the division between Kalispell and the Kootenai having the heaviest grades on the line.

Projects and Surveys.

Long Beach & Alamitos.—Chartered in California to build a railway from Long Beach to Alamitos, Cal., 3 miles. Among the incorporators are: E. Bouton, T. B. Burnette and others, of Los Angeles, Cal.

San Joaquin Valley.—It is stated that the money necessary to complete the first 100 miles of this railway from Fresno, Cal., to the timber lands has been secured, and that the contracts for construction will be let at once.

Port Angeles Southern.—Very good progress is being made in securing subscription to the stock of this company. About $300,000 of the necessary $350,000 have been secured. The road is projected to run from Port Angeles to Junction City, Wash., 40 miles. President, F. S. De Wolf, Seattle, Wash.

FOREIGN.

Ciudad Porfirio Diaz & Monterey.—The Mexican Government has granted a concession to José Valenzuela for a railway from Ciudad Porfirio Diaz to Monterey, Mex. A subvention of $8,000 per kilometre is granted in aid of the road.

Tabasco & Chiapas.—A concession has been granted to Octavio Maldonado by the Mexican Government for building a railway from a point on the Teapa River, in the State of Tabasco, through the town of Ixtapangajoga to Solosuchiapa, in the State of Chiapas, with power to extend the line to Santa Fe and to build a branch to Teapa.

CITY TRANSIT.

Electric Railways.—New lines or extensions are reported as probable in the following places: Pittsburg, Pa., address J. W. Martin; Atlanta, Ga., address the Consolidated Street Ry. Co. and the West End & Atlanta Street R. R. Co.; New Albany, Ind., address the Highlands Ry. Co.; Detroit, Mich., address the Detroit Street Ry. Co.; San Jose, Cal.

Little Compton, R. I.—At a town meeting held in Everton, R. I., June 26, it was voted to grant permission to Col. Sisson to build and operate a line in the town. The road is to be a portion of the 6-mile line running between Little Compton, Beaconnet Point and Everton.

Providence, R. I.—The Union R. R. Co., which has received permission to use electricity on a part of its system, will probably rent power from the Narragansett Electric Lighting Co. The No. 4 trolley wires, which are to be of silicon bronze, will be supported by wires stretched between iron poles on both sides of the street, and not by arm poles. The cars will probably be 25 ft. long. Recent press dispatches state that the city attorney has declared the franchise illegal.

Ballston Spa, N. Y.—At the last meeting of the Village Trustees application was made for a franchise for a passenger and freight railway. It is intended to extend the line to Rock City Falls, 9 miles distant, and connect there with the Delaware & Hudson R. R.

Dunkirk, N. Y.—The Cleveland Construction Co. will, it is reported, begin work shortly on the Dunkirk & Fredonia R. R.

Charleston, W. Va.—All the preliminary work of organization has been done on the new line to be built between Kanawha City and Charleston, and the company will be ready to ask for bids in a few weeks. The right of way, 3 miles long, has been secured.

Memphis, Tenn.—The petition of the Raleigh Springs R. R. Co. for a franchise over certain streets has been favorably reported by a special committee of the Council appointed to examine it. The city attorney has been ordered to draw up the necessary papers. The company agrees to pave between its tracks and pay a part of the cost of lighting the streets it occupies.

Mattoon, Ill.—It is reported that ordinances granting right of way for the Mattoon & Charleston Electric Street Ry. have been passed and that the stock has all been subscribed.

Leadville, Colo.—It is reported that the projected line to Evergreen Lakes will be built within a year at a probable cost of $500,000. New York parties have contracts amounting to $250,000, but no tracklaying will be done until the dams for developing the water power along the route are completed.

Austin, Tex.—The City Street Ry. Co. and the Rapid Transit Co. are reported to have agreed on their respective territories. The City company will, it is said, at once change to the electric system and begin its extensions.

Horse Railway.—***Carthage, Mo.***—The City Council has granted a 30-years' franchise to the Carthage, Carterville & Joplin Rapid Transit Co., the line to be in operation by May 1, 1892.

Dummy Railways.—New lines or extensions are reported as probable in Portland, Ore; address the Morrison Street Bridge Co. and the Mt. Hood Ry. Co., San Bernardino, Cal.; address Judge Gregg.

Martinsburg, W. Va.—The Martinsburg Mining & Mfg. Co. has engineers at work on a belt line to surround the town and connect the various mining, manufacturing and mercantile establishments with the railways.

Monroe, Ga.—A charter is being drawn for a dummy railway between Alcava Station, on the Georgia R. R., and Jersey, 5 miles distant. J. Blasingame, of Social Circle, is the promoter.

New Companies.—City Traction Co., Pittsburg, Pa.; capital stock, $25,000; incorporators, J. W. Martin, S. C. Nelson, R. B. Ward, S. Kelley, J. H. Cook. Anderson (Ind.) Electric Street Ry. Co.; capital stock, $200,000. Cedar Rapids & Marion City Ry. Co., Cedar Rapids, Ia.; capital stock, $400,000. Bath (Me.) Street Ry. Co.; capital stock, $100,000. Waterville & Fairfield Light & Railway Co., Waterville, Me.; capital stock, $200,000.

HIGHWAYS.

New York.—The Liberty & Neversink Turnpike Co. has been organized at Middletown. The Town Board of Schuyler Falls has employed W. M. Johnson, of Plattsburg, to survey a new road. Proposals will be advertised for by the Town Clerk.

California.—The Board of Supervisors of Ventura Co. will build a road to the Kern Co. line.

Washington.—A movement is on foot in Skagit and Whatcom counties to build a road 45 miles long from Sauk City into the Cascades for the purpose of tapping the Silver Creek and Monte Cristo mining districts. The people at Mount Vernon are stirring for a system of wagon roads.

BRIDGES, TUNNELS AND CANALS.

Bridges.—***Port Allegany, Pa.***—An iron bridge will be built across Marvin Creek. Bids for the foundations have already been advertised for.

Boston & Maine R. R.—A press report states that this company will build a $4,000,000 bridge across the St. Lawrence River.

Belmont Co., O.—The contracts for 11 new bridges in Belmont Co., O., were let last week by the special Commissioners appointed by the County Court to have charge of the construction of new pikes in Pultney Township. The Milligan bridge was let to McMillan Bros. at $4.72 per yd., the Klee and Neff bridges to the same parties at $4.92 per yd., and the other 11 to Galagher & Day at $5.17 a perch. The Commissioners will ask for bids for furnishing and putting up the steel superstructures soon.

Rock Island, Ill.—Bids will be received until July 25 for building an iron viaduct at this place. Capt. M. W. Lyon, Arch. Dept. U. S. Army, Rock Island Arsenal.

WATER-WORKS.

NEW ENGLAND.

Kennebunk, Me.—The Mousam Water Co. has organized with S. T. Fuller, President; W. L. Dane, Secretary; F. M. Ross, Treasurer. A charter was granted by the last legislature.

St. Johnsbury, Vt.—It is reported that the St. Johnsbury Aqueduct Co. will lay new pipe at an estimated expense of $25,000.

Boston, Mass.—Bids are wanted by the Water Board until July 7 for excavation for stripping and shallow flowage in Basin No. 5. Bids may be on either or all of four sections, the amount of excavation in each being, approximately, 78,900, 82,700, 83,500, 60,400 cu. yds. Bonds to

the amount of $100,000 have been voted for main extensions.

Leominster, Mass.—The contract for a new reservoir has been let to Augustus Laucier, of South Framingham.

Marblehead, Mass.—The town has appropriated $10,000 for use of the commissioners.

Methuen, Mass.—The town has been authorized to build works. A vote on the acceptance of the enabling act was taken June 27. A small fire protection system is now in use.

Plymouth, Mass.—The commissioners have been authorized to lay a main down Plymouth Beach, under certain conditions, at an expense of $5,'00.

Worcester, Mass.—The Water Committee has recommended to the Council that pipe be laid in several streets.

Albany, N. Y.—Large distributing mains have been ordered laid in two or three streets.

Brooklyn, N. Y.—The contract for furnishing stone for the Prospect Hill stand-pipe has been awarded to John Pierce. Brooklyn, for $44,750, delivered. T. B. Rutan, Brooklyn, has the mason work contract at $26,108.

Cattaraugus, N. Y.—A franchise has been granted to a new company with a capital stock of $20,000. The present works were built in 1890.

Ithaca, N. Y.—E. M. Treman, Secretary, says that the only extensions this year will be 3,000 ft. of 8-in. main and a Deane high-service pump.

Lyons, N. Y.—An increased supply is projected.

Marlborough, N. Y.—Works are projected by outside parties.

Mayville, N. Y.—G. E. Leet, Secretary Water Commissioners, informs us that plans for the proposed works have just been received, and will probably be presented to the people for acceptance in about three weeks.

Medina, N. Y.—New York parties have offered to take the franchise now held by Bassett Bros., Buffalo, and put in works provided the citizens will subscribe for water.

Syracuse, N. Y.—The Court of Appeals has reversed the judgment of the General Term and affirmed that of the Special Term, which means that Syracuse may issue bonds for works, and introduce a supply from Skaneateles Lake. On July 14 the commission to appraise the value of the company's works, which the city proposes to buy, will reconvene.

Walden, N. Y.—Plans and estimates for works have been made. A Water Board was organized May 12.

Westport, N. Y.—We are informed that estimates for works are being made by Portland parties.

Rutherford, N. J.—The Rutherford Water Co. has been incorporated; capital, $100,000.

Morrisville, Pa.—W. H. Moore, Secretary, informs us that the Board of Trade is urging the building of works, and has appointed an investigating committee. Pumping from the Delaware River to a reservoir or stand-pipe is proposed. Population about 1,500.

Shrewsbury, Pa.—A charter has been granted to the Shrewsbury Water Co.; capital, $2,500; directors, James Gerry, J. H. Markel and others.

Elkton, Md.—F. A. Blake, President Council, has sent the following:

Construction has been started by the Elkton Water Co. with Young Bros., 1404 South Penn Sq., who were granted the franchise, as Contractors, and I. S. Cassin, Philadelphia, Engineer. Water will be pumped from wells to a 1,000,000-gall. reservoir, and there will be 5 miles of mains.

SOUTHERN.

Front Royal, Va.—H. L. Cook, has sent the following:

The proposed Royal Water Co. has not yet been incorporated, but surveys for works have been made and estimates are under way. A line for a conduit 8,880 ft. long has been located from the source of supply to the proposed 4,000,000-gall. reservoir. The latter is 48 ft. below the source and 218 ft. above the center of the town. It is expected that the work will be under contract before Aug. 1.

Newport News, Va.—It is reported that the Newport News Light & Water Co. has completed surveys for its 18-mile supply main from Warwick River, ordered pipe, and will have water in town by October. Theodore Livezey is connected with the company.

Luray, Va.—T. E. McConkle, of Lexington, Secretary of the Valley Land & Improvement Co., informs us that a proposition to the town and the company might result in securing a franchise for works. Population, 2,500.

Elkins, W. Va.—T. A. Fleming, Recorder, has sent the following:

Bonds for town works have been voted, surveys are being made and contracts will probably be let by July 10. The supply will be pumped from the Monongahela River to a reservoir or tank. Population, including suburbs, 2,000.

Mannington, W. Va.—The Mannington Water Supply Co. has been incorporated; capital, $25,000.

Fayetteville, N. C.—D. F. Wemyss informs us that the National Water Supply & Guarantee Co. will probably begin to build works July 10. Water will be pumped to a stand-pipe. Estimated cost, $50,000.

Marion, N. C.—Address James Morris, Mayor, regarding proposed city works.

La Grange, Ga.—E. D. Pitman informs us that negotiations regarding the granting of a franchise are in progress. J. F. Park is Mayor.

Macon, Ga.—B. F. Church, New York, has been engaged to report upon the proposed city works.

Savannah, Ga.—Improvements to the works are still being discussed.

Wrightsville, Ga.—V. B. Robinson informs us that on July 10 the people will vote on issuing bonds to complete works. The pump and tank are in place and pipe is necessary to complete the works.

Huntsville, Ala.—R. E. Hartford, Chattanooga, will report on a proposed new reservoir.

Piedmont, Ala.—J. H. Cooke, Secretary Board of Trade, informs us that offers for a 20-years franchise are still wanted. Negotiations are pending, but no award has been made.

Chattanooga, Tenn.—The Chattanooga Water & Electric Co., of Chicago, Ill., has been incorporated to operate electric lights, water works, street railway and a pleasure resort here.

Smith's Grove, Ky.—It is reported that a company is being organized to pipe water from a spring 5 miles from town; also to pipe natural gas.

Rowland, Ky.—We are informed that J. N. Peyton, of Stanford, is pushing for works here.

NORTH CENTRAL.

Hillsboro, O.—Works are wanted.

Norwalk, O.—The Trustees will receive bids till July 7 for laying and relaying pipe. A. Joslin is Secretary.

Somerset, O.—The business men are discussing works.

Wellston, O.—J. M. Ervin, Mayor, informs us that bids for building works, to be owned by the city, will be received until July 20. Population, about 5,000.

Mason, Mich.—The following is from a resident:

The works, for which $35,000 of bonds have been voted, will include a supply pumped from wells. Contracts will probably be let about Aug. 1. Address Mayor Murray or L. C. Webb. Population, 2,000.

Plymouth, Mich.—A vote for works, to cost not over $39,000, has been carried by 114 majority. Plans will be made at once.

Centralia, Ill.—Works drawing a supply from Crooked Creek, and estimated to cost $65,000, have been recommended by Engineer Joyce, St. Louis, Mo.

Chicago, Ill.—H. B. Herr & Co., of Chicago, have been awarded the contract for sinking 3 wells, 8 ft. in diameter, 50 ft. deep, and constructing about 1,000 ft. of tunnel, 5 ft. in diameter, for supplying additional pumps at the 68th pumping station, from which water is to be taken to supply the building of the Columbian Exposition. Contract price, $27.50 per lin. ft. of shafts, $13.50 per lin. ft. of tunnel.

Pontiac, Ill.—We are informed that contracts for $50,000 city works will probably be let soon. Address the Mayor. Population, 4,000.

NORTHWESTERN.

Albia, Ia.—The people have voted for water-works and electric lights.

Perry, Ia.—T. L. Townsend, City Clerk, informs us that A. L. Strang & Sons, Omaha, have the contract for works, including 4 miles of mains and 30 hydrants.

Sheldon, Ia.—The electors have voted for works. It is reported that the Council will, within 30 days, grant a franchise to W. A. Calhoun, Green Bay, Wis.

Duluth, Minn.—It is reported that the city is considering the construction of works, there being dissatisfaction with the company's supply.

La Verne, Minn.—Albert Black, Recorder, informs us that Harrison & Hawley, St. Paul, have just received the contract for works at $23,256

Madelia, Minn.—Bids are wanted by the village until July 29 for constructing a high tank, furnishing and laying mains. C. Cooley is Recorder. The supply will be from a well in the park.

Chadron, Neb.—On July 6 the people will vote on the issuance of $20,000 of bonds for changing from a direct pumping to a gravity system. The present supply is said to be insufficient.

Tekamah, Neb.—Water bonds to the amount of $13,000 have sold.

Deadwood, S. Dak.—The sum of $40,000 has been voted by the city for improving sewers and establishing waterworks. Company works are now in operation.

White Sulphur Springs, Mont.—The Council will receive bids until July 13 for works on the franchise plan. Bids must outline the system proposed and state rental for hydrant and domestic service.

SOUTHWESTERN.

Oak Cliff, Tex.—The works are being improved.

Houston, Tex.—It is reported that a franchise for a second company will be asked, and that John T. Lakin, Chicago, will report to those interested in the project. The present works were completed in 1879.

Sulphur Springs, Tex.—W. D. Byrd, City Secretary, informs us that to June 23 no franchise had been granted, but that negotiations were pending.

Louisville, Col.—The following is from W. Condery, City Clerk:

The village proposes to let the contract for works July 15. The supply will be by gravity. Estimated cost, $25,000. Bonds have been voted, but not sold. Mayor, J. M. Wilson. Population, 800.

Spokane Falls, Wash.—Bonds for water-works improvements have been voted, the amount, according to former reports, being $500,000. A new reservoir is urged.

Woodlawn, Wash.—Bids will be received until July 6 for preparing plans, specifications and estimates for works to cost not above $50,000. Address R. B. Mosby, City Clerk.

Union, Ore.—W. F. Wright, Mayor, informs us that the water-works contract has been awarded to Dion Keefe Walla Walla, for $18,000.

CANADA.

Sandwich, Ont.—The vote on the water-works by-law has been postponed for two months from June 22.

Woodstock, Ont.—W. M. Davis has sent the following:

Town works will be built this season after plans recommended in 1890 by T. C. Keefer, with Davis & Van Buskirk Constructing Engineers. Estimated cost, $105,000. The supply will be brought by gravity to the town limits, about three miles, in earthenware pipes. From this point it will be pumped directly to the mains.

ARTESIAN WELLS.

Paterson, N. J.—The Committee on Lamps, Wells and Pumps wish bids at once for sinking wells. Alderman Hartly is on the committee.

Toledo, O.—The Council has instructed the City Clerk to advertise for bids to sink four wells.

Manton, Mich.—A well will be sunk.

Pana, Ill.—A well for a general water supply is reported as under consideration.

Grinnell, Ia.—Test wells for a water supply will be sunk.

Niobrara, Neb.—A company has been organized to sink a well for water-works and to furnish power for a grist-mill. It is proposed to issue $6,000 of township and village bonds to aid the company.

Aberdeen, S. Dak.—The Dakota Irrigation Co. has contracted with a Pittsburg firm for sinking 10 wells.

Mesquite, Tex.—A well is projected by the citizens.

Wills Point, Tex.—The Council has been petitioned to levy a tax to pay for the boring of a well.

IRRIGATION.

Crawford, Neb.—A company in which C. J. Grable is interested has recently been organized and talks of diverting White River, at a point four miles above the town, to an artificial lake of 40 acres to be located about one-half mile from town. From the lake it is proposed to lay pipe for irrigating and manufacturing purposes.

Red Willow Co., Neb.—D. E. Doty, David City, has the contract for 12 miles of canal. The canal will be 20 ft. wide and will carry 4 ft. of water.

Wallula, Wash.—The formation of an irrigation district is talked of. Another plan is to accept the proposition of San Francisco parties to build a ditch from Snake River capable of irrigating 10,000 acres, this amount of land to be bonded to the company to secure the payment of a yearly rental of $2 per acre.

Fresno, Cal.—A company has been organized to build the "Pine Ridge Flume." This project includes, first, the construction of a large reservoir in the mountains having, with a 60-ft. draft, a capacity of 27,000,000,000 acres and a drainage area of 38 sq. miles. The flume as planned would be 52 miles long and would extend to Fresno. For the present it is proposed to build the flume only about half way, or to the plains. Ultimately the flume would be used for irrigation and for floating lumber, and water power schemes are mentioned.

Modesto, Cal.—Later reports state that the contract price for the joint rubble masonry dam is $10.39 per cu. yd., or about $350,000, instead of the amount mentioned last week.

San Jacinto, Cal.—J. M. Manly, of Los Angeles, Secretary of the Lake Hemet Water Co., informs us that the laying of rock was started in June last. Water will be stored for the irrigation season of 1892, but the works will not be completed by that time. The company has an authorized capital of $2,000,000. W. F. Whittier, San Francisco, is President; J. D. Schuyler, San Diego, Designing Engineer, and E. L. Mayberry, Constructing Engineer and General Manager.

New Companies—Honey Lake Valley Land and Water Co., Lassen Co., Cal., $1,000,000; Jerome B. Cox and William P. Sullivan, Jr., San Francisco, Fred. W. Lake, Oakland, and others; Los Angeles Irrigation Co., Los Angeles Cal., $500,000; Butte & Market Lake Canal Co., Market Lake, Ida., $150,000.

SEWERAGE AND MUNICIPAL.

Sewers.—*New Hampshire.*—Lebanon. Surveys are being made by G. H. Allen and A. B. Downs.

Massachusetts.—Westboro. The Selectmen have purchased additional land for the sewage disposal work.

Rhode Island.—Pawtucket. The Board of Health has made its report, recommending irrigation and downward intermittent filtration for sewage disposal.—Berkeley. The Berkeley Co. is putting in a system of 4, 6, 8 and 10-in. pipe, with an outfall to the Blackstone River. All inside work is of 2 in. iron pipe. There will be 13 manholes.

New York.—Rochester. Mr. H. H. Edgerton, Mr. W. H. Gorsline and Mr. J. T. Alder have been appointed Commissioners for the East Side trunk sewer.—Jamestown. The Board of Health has decided to ask the State Board of Health to compel the Council and Board of Public Works to put in sewers.—Gloversville. A number of sewers are projected.

New Jersey.—Bayonne. The proposition to build two 54-in. main sewers, 11,800 ft., has been abandoned, the cost being estimated at $150,000 to $200,000, which would make the assessments too high.—Bloomfield. The town will

spend $30,000 on the main trunk sewer from Weaver Ave. to the Passaic River; Orange and Montclair will co-operate in the work.—Newark. A new wooden flume for the intercepting sewer has been recommended by the Board of Works.

Pennsylvania.—Williamsport. The sewer bill has been passed.—Pittston. A sewerage system is projected.

Georgia.—Macon. Mr. B. S Church, of New York, has been engaged to prepare plans and estimates for the completion of the sewerage system.

Alabama.—Mobile. A company has applied for a sewerage franchise. Mr. Robert Gage is interested.

Michigan.—Ann Arbor. The Common Council has adopted the reports of the joint committees on sewerage recommending that a committee be sent to Lansing to try to get an enabling act passed authorizing the bonding of the city in the sum of $20,000.—West Bay City. City Engineer Blomshield reports that $10,000 will be spent this year on sewers, including a brick sewer 20 × 33 ins., 15, 18 and 20-in. socket tile, and lateral tile sewers.

Missouri.—Springfield. Proposals for the construction of a system of sewerage will be received by G. W. Hackney, City Clerk.

Washington.—Puyallup. On recommendation of the City Engineer a separate system of sewerage is to be built; vitrified iron-stone pipe will be used, 15-in. for mains and 12-in. for sub-mains. The cost is estimated at $45,265.

Los Angeles, Cal.—The City Engineer has submitted a plan for an outfall to the ocean, at an estimated cost of $350,000.

Streets.—*New York.*—Lockport. Asphalt or brick paving is to be laid on Genesee St.

Virginia.—Roanoke. Bids will be advertised for 10,000 sq. yds. of brick paving.

North Carolina.—Asheville. It is proposed to spend a considerable amount on street improvement.

Ohio.—Youngstown. Brick paving is being laid.

Michigan.—Detroit. A contract for brick paving has been let to J. A. Stewart.—West Bay City, Md. J. H. Blomshield, City Engineer, reports that $75,000 will be spent this year on cedar block paving, cobblestone gutters and stone curbing.

Illinois.—Springfield. Brick paving is to be laid, and brick manufacturers are figuring on the work.

Missouri.—Westport. Main St. is to be paved with asphalt for 1¼ miles, and brick for 2 blocks.—Chillicothe. It is proposed to spend $30,000 on street paving.

Bonds.—Dayton, O.; $38,000 for sewers; bids received July 27; C. A. Herbig, City Auditor. West Troy, Troy, N. Y.; $70,000 for paving. Deadwood, S. Dak.; $40,000 for sewers and water-works. Warren, O.; $12,000 for sewers; purchased by the Western Reserve National Bank.

ELECTRICAL.

Electric Lighting.—New plants or extensions are reported as probable at Grand Rapids, Minn.; East Portland, Ore., address George Brown; Albia, Ia.; Sanford, Fla.

Alexandria, Va.—The operating expenses of the electric light plant (about 100 arcs capacity) are stated by Chairman McKenzie, of the Light Committee of the Council, to be as follows: Labor for 12 mos., $3,880; coal, 502 tons, $1,526; carbons, $702; oil and waste, $207; repairs, $25; total, $5,345.

Wheeling, W. Va.—The city election to decide on purchasing a municipal plant resulted in a vote of 3,014 for the plant and 811 against. As the "for" vote exceeded the necessary two-thirds, the plant will probably be built.

Santa Rosa, Cal.—The following bid for street lighting was recently received by the Trustees: J. G. Gardner, thirty or more arcs of 2,000 c. p. at $9 per month when extinguished at 1 a. m. and $11 when burning all night; price for same number of 1,600 c. p. arcs is $8 and $10 respectively.

Seattle, Wash.—The City Council has granted a 25-years' charter to Chas. H. Baker to build and operate a lighting and power plant.

New Companies.—Electric Packet Co., St. Louis, Mo.; capital stock, $7,000,000; incorporators, H. H. Likmeke, J. W. Whitelsey, G. Frey, J. B. Schmidt, H. D. O Brien. Harvard Electric Light & Power Co., Harvard, Ill.; capital stock, $15,000; incorporators, J. E. Keely, A. W. Young, E. L. Church. Platteville (Wis.) Electric Light & Power Co.; capital stock, $10,000; incorporators, J. H. Evans, W. G. Jennings, W. L. Corkwood, O. E. Gibson, D. E. Gardner. River Falls (Wis.) Light, Heat & Power Co.; capital stock, $50,000; incorporators, F. J. Burbyte, R. N. Jenson, W. W. Thayer, and others. Heat, Light & Power Co., Chicago, Ill.; capital stock, $20,000,000; incorporators, D. E. Davis, T. & W. Barratt, T. D. McKay, E. Kaufman. Interstate Complete Electric Construction Co., St. Louis, Mo.; capital stock, $10,000; incorporators, C. P. Lampee, W. & E. Werdock. Santa Ana (Cal.) Gas & Electric Co.; capital stock, $100,000. Laclede Power Co., St. Louis, Mo.; capital stock, $75,000. Bellevue (O.) Light & Power Co.; capital stock, $20,000.

CONTRACTING.

Brick, Sand, Etc.—*Washington, D. C.*—The District Commissioners have awarded contracts as follows: Terra-cotta invert block, August Lamond, 50 cts. per lin. ft.; vitrified brick, McMahon, Porter & Co., $25 per 1,000; paving brick, Ivy City Brick Co., Ivy City, D. C., $10.25 per 1,000; paving sand, J. T. Summers, 59 cts. per cu. yd.; fine screened sand, J. B. Lord, 60 cts. per cu. yd; pebbles, J. T. Summers, 95 cts. per cu. yd.; C. J. Smith & Son, broken stone, $1.75 per cu. yd.

Sewers.—*Holyoke, Mass.*—The Sewer Committee has awarded contracts on the Mosher St. sewer as follows: Brick; Baker, Cavanaugh & Verill, $16 50 and $15.40 per 1,000; stone work, Delaney Bros., $4.65 per cu. yd.; piles, F. A. Rivers, $6.60, $5 and $4 for 25, 18 and 12 ft. piles.

Baltimore, Md.—Propcsals have been received as follows for the materials for the extension of the Jenkins Run sewer: Stone; John Curley, $2 per cu. yd.; John H. Atkinson, $2.25; John Harris, $2.15. Sand; Leonard & McGovern, 85 cts. per cu. yd.; Patrick Keelty, 84 cts. Brick; Kline Bros., $8.25 per 1,000, hand made; G. W. Robinson & Son, $7.35, hand made, $7.25 machine made; G. W. Robinson, Jr., & Bros., $7.90 and $7 75; W. H. Perot, $7.40 and $7.50; Maryland Brick Co., $7.50 machine made. Paving blocks; Albert Weber $140 per 1,000, $2.90 per cu. yd.; McLanahan & Bro., $130 and $2.35; Guilford & Waterville Granite Co., $130 and $2.60. Cement; John S. Bullock & Son, Round Top, in bags, $1.18; Portland, in barrels, $2.90; F. O. Norton, in barrels, $1.35; S. M. Hamilton & Co., Cumberland, in bags, $1.18; Portland, in barrels, $2.90; Burham, in barrels, $2.75; C. C. McColgan, Rosendale, in barrels, $1.28; Crescent, in bags, $1.10, and Stettin Anchor, in barrels, $2.85.

Menominee, Mich.—The contract for 9 miles of sewers has been awarded to John C. Larson, of Menominee, at $94,000.

Montreal, Canada.—Contracts for drains have been awarded at the following prices: Rock excavation, $4; concrete, $6.50; pine planks, laid, $15 per 1,000; brick drain, $18 per yd.; 6, 9 and 12-in. connections, $2, $2.50 and $4.

Streets.—*Long Island City, N. Y.*—The contract for grading Jackson Ave., Vernon Ave and the Boulevard has been awarded by the Improvement Commissioners to Cranford & Valentine, of Brooklyn, at $169,012. This is part of a large work including grading, sewering, paving and sea wall, the total cost of which will be about $600,000.

Salt Lake City, Utah.—The Board of Works has recently opened proposals for brick, asphalt and flag paving for sidewalks: Grading, 33 to 43 cts. per cu. yd. for earth, $1 for rock; brick paving, 8 and 9½ cts. per sq. ft.; sheet asphalt, 16 and 18 cts. per sq. ft.; bituminous rock, 15½ and 18¾ cts.; 3, 4 and 5 in flagstone, 35 to 42 cts., 39 and 40 cts., 45 to 55 cts.

Williamsport, Pa.—The contract for brick paving has been awarded to D. P. Gurse at $2.45 per sq. yd.

Pipe.—*Montreal, Canada.*—The contract for cast-iron water pipe has been awarded to H. C. McLaren & Co. at $31.50 per ton.

Dredging.—*Washington, D. C.*—The following proposals for dredging in the Potomac River were opened June 25 by Lieut.-Col. P. C. Hains, U. S. Engineer Office: F. G. Somers, Camden, N. J., 15½ cts. per cu. yd.; Alabama Dredging & Jetty Co., Mobile, Ala., 17 cts.

PROPOSALS OPEN.

Street Work.—*Dunkirk, N. Y.*—Telford macadam paving and vitrified brick paving. Also curbing, crosswalks and 4-in. tile drain. Full particulars will be found on our advertising p. xviii. F. A. Dunham, City Engineer; F. C. Nagle, City Clerk. July 17.

Bridge.—*Williamsett, Mass.*—Superstructure of bridge over the Connecticut River. Consulting Engineer, E. S. Shaw, 146 Franklin St., Boston, Mass.; Leonard Clark, Chairman of Hampden Co. Commissioners, Springfield, Mass. July 14.

Viaduct.—*Rock Island, Ill.*—Iron viaduct approach to wagon bridge. Capt. M. W. Lyon, U. S. Arsenal. July 25

Highway.—Clearing, grading, grubbing, ditching and planking for county road. T. A. Twichell, County Auditor, Seattle, Wash. July 6.

Excavation.—*Boston, Mass.*—In basin No. 5; 78,900 cu. yds., 82,700 cu. yds., 80,500 cu. yds. and 60,400 cu. yds. in section A, B, C and D. The Water Board. July 7.

Dredging and Mattress.—Dredging Cedar Bayou, Tex.; revetment walls of brush mattress, ballasted with stone and dredged material. Major C. J. Allen, U. S. Engineer Office, Galveston, Tex. July 25.

Pipe.—*Washington, D. C.*—Terra-cotta pipe and branches; 6, 8, 10, 12, 15, 18, 21 and 24-in. pipe. The District Commissioners. July 6.

Street Work.—*Asheville, N. C.*—Paving according to specifications on file. W. R. Young, City Clerk. July 15.

Denver, Colo.—Trinidad asphalt pavement on 6 ins. of concrete. J. E. Bates, President Board of Public Works. July 21.

Sewers.—*Martinez, Cal.*—J. T. Bush, City Clerk. July 14.

Terre Haute, Ind.—Brick, double ring, 28 × 42 ins. to 36 × 54 ins.; pipe, 12 to 15 ins.; manholes and basins. A. C. Duddleston, City Clerk. July 21.

Surveying.—*Sumter, S. C.*—Surveying and mapping the city. W. A. Pringle, Jr., City Clerk. July 15.

MANUFACTURING AND TECHNICAL.

Locomotives.—The Baldwin Locomotive Works, of Philadelphia, Pa., have an order from the Southern Construction Co. for 8 engines for the South Bound. The Rhode Island Locomotive Works, Providence, R. I., are building engines for the Toledo, St. Louis & Kansas City.

Cars.—The Wagner Palace Car Co., Buffalo, N. Y., has built 2 vestibule cars for the Adirondack & St. Lawrence. The Wason Car Mf. Co., of Springfield, Mass., is building 10 suburban cars for the Boston & Maine, similar to those of the New York elevated roads. They will be 40 ft. long, seat 48 passengers and weigh 39,000 lbs. The Michigan Central builds its own passenger cars. The Michigan Car Co., of Detroit, Mich., is building 500 box cars for the Toledo, St. Louis & Kansas City. The National Mfg. Co. has been incorporated at Seattle, Wash., to build cars, etc.; $250,000. The United States Rolling Stock Co., of Anniston, Ala., is to be reorganized. The Grand Trunk will establish car works at London, Ont.

Car Coupler.—The Hinson Car Coupler Co., of Chicago, Ill., has received several good orders for its "Improved Hinson" M. C. B. coupler, which was exhibited at the Cape May convention.

Trolley Track.—It is stated that in the U. S. Circuit Court, district of Massachusetts, in the case of the Dunham Mfg. Co., now the Q. & C. Co., against the Coburn Trolley Track Mfg. Co., a final decree and permanent injunction has been given against the latter for infringement.

H. B. Herr & Co., of Chicago, Ill., have the contracts for a masonry breakwater, 2,000 ft. long, and for the foundation of the warship model at the Columbian Exposition. They will also continue the driveway started in Lincoln Park at an estimated cost of $18,000.

Binder & Seifert, of Chicago, Ill., have the contract for the iron and steel work of the German Opera House building, about 1,400 tons, at $122,900; also for the iron and steel work for the dome of the Horticultural Building, Columbian Exposition.

The Consolidated Car Heating Co. has established an equipping department, under the charge of Mr. J. H. Sewall as Superintendent of Equipment, with headquarters at Chicago. He will have charge of the application of all the company's appliances throughout the United States and Canada.

Sale.—The plant of the Milwaukee Bridge & Iron Works, Milwaukee, Wis., will be sold at auction July 18.

Companies.—Chicago Water Wedge Co., Chicago, Ill.; to manufacture hydraulic machinery; J. D. Rand, H. J. Hulskamp, Morris Sellers; $50,000. Maryland Tube & Iron Works, Hagerstown, Md.; President, H. O. Chapman, Philadelphia, Pa.; $60,000. Covington Machine Co., Covington, Va.; W. A. Rinehart; $500,000. Hydraulic Dredging & Improvement Co., Camden, N. J., and Philadelphia Pa.; T. C. Somers, Camden; L. A. Chandler, East Orange, N. J.; J. W. Wilson, Philadelphia, Pa.; $300,000. American Pneumatic Gate Co., Chicago, Ill; railway crossing gates; F. O. Lewden, T. Shissler and E. S. Walker; $24,000. The Michigan Paving & Construction Co., Detroit, Mich.; $100,000. Sherman Nut Lock Co., Detroit, Mich.; $100,000. Omaha Stradamant Asphalt Co., Omaha, Neb.; W. T. Barton, W. H. Warsick and F. J. Kaspar; $180,000.

Metal Market Prices.—*Rails.*—New York: $30 75 to $31; old rails, $20.50 for iron and $17 for steel. Pittsburg: $30; old rails, $22.50 to $23 for iron and $17 to $18.50 for steel. Chicago: $31 to $32; old rails, $23.75 to $24 for iron and $14.50 to $17 for steel.

Track Materials.—New York: steel angle bars, 1.7 to 1.8 cts.; spikes, 2 to 2.1 cts.; track bolts, 2.65 to 2.8 cts. Pittsburg; splice bars, 1.8 to 1.9 cts. for iron or steel; iron or steel spikes, 2 to 2.05 cts.; iron track bolts, 2.75 cts. with square and 2.80 cts. with hexagon nuts. Chicago: splice bars, 1.8 to 1.9 cts. for iron, 2 cts. for steel; spikes, 2.15 to 2.2 cts.; track bolts, 2.8 to 2.9 cts. with hexagon nuts.

Foundry Pig Iron.—New York: $14 to $18. Pittsburg: $14.75 to $17. Chicago: $14 to $18.50.

Pipe.—Cast iron, $25 to $30 per ton. Wrought iron, discounts as follows, at Pittsburg: 55 and 45 per cent. on black and galvanized butt-welded; 65 and 52½ on black and galvanized lap-welded. Casing, 55 per cent.

Lead.—New York: 4.47 to 4.5 cts. Chicago: 4.25 to 4.35 cts St. Louis: 4.3 to 4.35 cts.

Structural Material.—New York; beams, 3.1 cts.; channels, 3.1 cts.; angles, 1 95 to 2.1 cts.; tees, 2.45 to 2 75 cts.; sheared iron plates, 1.95 to 2.25 cts.; steel plates, 2 to 2.15 cts. for tank, 2.3 to 2.6 cts. for shell, 2.5 to 2.7 cts. for flange, 3.75 to 4.25 cts. for firebox. Pittsburg: beams, 3.1 cts.; channels, 3.1 cts.; angles, 2 cts.; tees, 2.6 cts.; universal iron mill plates, 2.05 cts.; sheared steel bridge plates, 2.1 to 2.15 cts.; refined bars, 1.8 to 1.85 cts.; steel plates, 2.1 cts. for tank, 2.45 cts. for shell, 2.65 cts. for flange, 3.9 to 4.25 cts. for firebox. Chicago: beams, 3.1 cts.; channels, 3.2 cts.; angles, 2 to 2.15 cts.; tees, 2.6 to 2.7 cts.; universal plates, 2.3 to 2.4 cts.; sheared plates, 2.5 to 2.6 cts. for iron and 2.6 to 2.7 cts. for steel; steel plates, 2.4 to 2.6 cts. for tank, 2.85 cts. for shell, 3 to 3.25 cts. for flange; 4.5 to 5.5 cts. for firebox; boiler rivets, 4.25 cts.